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Power-Factor Correction by Synchronous Motors

The Application of the Synchronous Condenser

We have frequently called attention in these columns to the value of a synchronous motor for regulating the power factor on alternating current circuits, as the operating troubles due to low power factors have been more or less numerous on alternating current circuits which supply induction motors, arc lamps and other inductive apparatus. This matter was clearly brought out in a paper read by Mr. F. D. Newbury at the recent convention of the National Electric Light Association, in which his following explanations and methods of correcting the power factor by the use of synchronous motors should prove valuable to those having those troubles and who want to correct them:

"Alternating-current systems have generally recognized and, in many cases, controlling advantages; they may have, on the other hand, one serious disadvantage not encountered in direct current systems—that of low power-factor. With the rapid increase in the industrial use of induction motors and in arc lighting by the alternating current, the troubles incident to low power-factor, in systems not designed for it, have become unfortunately familiar. It is the purpose of the present paper to point out the more important effects of low power-factor and to show how, in some cases, these bad effects may be overcome by the proper application of over-excited synchronous motors.

"Low power-factor has two serious results: it limits the capacity of the electrical part of the system by loading it up with unproductive current—current for which no revenue is obtained; and it means poor voltage regulation.

"When the power-factor is 100 per cent.—when the current and voltage are in phase—all the current is effective in doing work, and the kilowatts, measured by the wattmeter, are the same as the kilowatt-amperes, measured by a voltmeter and ammeter. At power-factors lower than 100 per cent.—when the current is not in phase with the voltage—only that component of the current that is in phase with the voltage is effective in doing work, and only this component is measured by the wattmeter. The ammeter, however, measures the total current. With power-factors lower than 100 per cent. the kilowatts are therefore less than the kilovolt-amperes, the ratio between them being equal to the power-factor. The rating of electrical apparatus depends, primarily, on the heating produced by the load, and this heating depends entirely on the current. The kilowatt load, therefore, unless the corresponding power-factor is taken into account, is not a measure of the actual load on the apparatus.

"This has an important bearing on the relative ratings of prime-movers and electrical apparatus. The capacity of prime-movers is determined solely by the energy load as measured by the wattmeter. The capacity of electrical apparatus—generators, transformers or feeders—is determined by the kilovolt-ampere load, which, with a given energy load, depends on the power-factor. The power-factor, therefore, should be taken into account in selecting a generator for a given engine. This, unfortunately, is done in very few cases. It is all too common to make the kilovolt-ampere rating of the generator equal to the kilowatt rating of the engine. The current load on the generator will only correspond with the energy load on the engine when the kilovolt-amperes equal the kilowatts, which is at 100 per cent. power-factor. At lower power-factors, the generator will be carrying more load, relatively to its rating, than the engine. It is putting the matter very conservatively when it is stated that in less than half the power plants designed, has the power-factor been taken into account, as it should be, in determining the relative ratings of the engine and generator. This means that in a large number of plants it is only the large overload capacity of the generators that enables them to put even full load on the engines.

"This unequal loading of the engines and generators is the only bad condition due to this effect of low power-factor. The revenue of a station is affected. The revenue depends on the kilowatt load and not on the kilovolt-ampere load, since power taken by customers is measured by wattmeter. Therefore, with low power-factor the generators, transformers and feeders are loaded up with current that can bring in no revenue. In a system in which the engines have a kilowatt rating equal to the kilovolt-ampere rating of the generators and other electrical apparatus the revenue-producing capacity of the system is cut down in direct proportion to the power-factor. At 70 per cent. power-factor, for example, the revenue will be only 70 per cent. of the revenue that could be obtained at 100 per cent. power-factor from the same current and same investment in electrical apparatus.

"Low power-factor, then, means that unless the system has been consistently designed for the power-factor at which it is operating, the different parts of the system are unequally loaded. If the engines are underloaded the possible revenue is curtailed; if the engines are carrying their rated load the electrical part of the system is overloaded, with attendant troubles and poor service to the customers.

"The second injurious effect of low power-factor is poor voltage regulation. This effect is well known and requires no extended explanation. It will suffice, in the present paper, to show how large this effect may be, considering in turn each part of the electrical system.

Considering, first, the generators—it has been the general practice up to this time to design generators for an inherent regulation of approximately 8 per cent. of their rated load and 100 per cent. power-factor. There is, however, a tendency toward higher regulation percentages, particularly in large units, since a considerable reduction in cost can be made without any corresponding sacrifice in practical operating performance. However, with a generator having 8 per cent. regulation at 100 per cent. power-factor, with the same current and 80 per cent. power-factor, the regulation, in the majority of cases, will be between 20 per cent. and 25 per cent., varying in different generators on account of more or less magnetic saturation. It is worth while noting that the more saturated a generator is, the better regulation it will have, particularly at low power-factors; so that while apparently the saturated generator is the better unit on account of better regulation, it is, in fact, the poorer unit, since it will not hold up its voltage under heavy loads so well as the more nearly unsaturated generator. This will be referred to later. At the same kilowatt load and 80 per cent. power-factor (which means 25 per cent. overload in current) the regulation will be between 25 per cent. and 30 per cent. The importance of inherent regulation of generators from an operating standpoint is minimized by the ease with which the excitation can be increased and thus compensate for the drop in voltage. This is particularly true provided an automatic voltage regulator is installed. Similar compensation in transformers or feeders requires relatively expensive auxiliary apparatus.

"In transformers of 60 cycles and in fairly large units—say between 200 kilowatts and 1,000 kilowatts—the regulation at 100 per cent. power-factor and normal rated current will be between 1.6 per cent. and 0.8 per cent. With the same current and 80 per cent. power-factor the regulation will be between 4 per cent. and 2.5 per cent. At 25 per cent. overload in current and 80 per cent. power factor, which is equivalent to normal load in kilowatts and 80 per cent. power factor, the regulation will be between 5 per cent. and 3 per cent.

"In small lighting transformers—up to 50 kilowatt capacity—the regulation will be poorer than in the larger transformers at 100 per cent. power-factor, and very nearly the same at 80 per cent. power-factor. At 100 per cent. power-factor the regulation of small transformers will lie between 2.7 per cent. and 1.3 per cent. At normal rated current and 80 per cent. power-factor the regulation will lie between 3.9 per cent. and 2.5 per cent., and at 25 per cent. current overload and 80 per cent. power-factor the regulation will lie between 5 and 3 per cent.

"The regulation of feeders is similarly affected by low power-factor, but the magnitude of the effect varies widely on account of the varying ratio between the resistance and reactance drops in different cases. With equal resistance and reactance drops and a total drop of 10 per cent. at 100 per cent. power-factor, the drop at the same current and 80 per cent. power-factor will be 13.5 per cent., and the drop at the same kilowatts and 80 per cent. power-factor will be 16.5 per cent. With a reactance drop double the resistance drop and a total drop of 10 per cent. at 100 per cent. power-factor, the drop at the same current and 80 per cent. power-factor will be 17 per cent., and the drop at the same kilowatts and 80 per cent. power-factor will be 23 per cent. With 60 cycles and a spacing of about twelve inches bteween wires, the reactance and resistance become equal with about No. 0 B. and S. gauge conductors. For larger conductors the reactance is greater and for smaller conductors the resistance is greater.

"It has been previously pointed out that the importance of inherent regulation of generators is minimized by the ease with which drop in generator voltage can be compensated for by increasing the field current. This is only true provided the field current can be sufficiently increased with the available exciting voltage. In any generator there is a maximum field current that can be obtained, determined by the resistance of the field winding and the available exciting voltage. If the load and power factor require a field current in excess of this maximum, it is obvious that the voltage will fall in spite of anything the station operators can do. The field current required depends somewhat on the current load, but largely on the power-factor. Unless a generator has been designed to carry loads of low power-factor the maximum field current obtainable will be insufficient to maintain the normal voltage under this load condition. If a generator has a saturated magnetic circuit the increase in field current required for loads of low power-factor is much greater than if there were less saturation. For this reason an unsaturated generator will give better operating performance, because it can carry heavier inductive loads, even though the percentage regulation will be lower than in a similar generator with more saturation. With a generator not suited for loads of low power-factor, either by reason of insufficient field current or saturation, it is possible, then, to have a serious drop in voltage in the generator, due to low power-factor.

"A caution is needed, in considering the bad effects of low power-factor, against concluding that a high power-factor is always better than a low power-factor without considering the means by which the high power-factor is obtained. The power-factor may be raised by decreasing the inductive load or by increasing the energy load. High power-factor obtanied by decreasing the inductive will always mean a gain; high power-factor obtained by increasing the energy load will only mean a gain provided the increase in energy load is accompanied by a corresponding increase in revenue. An increase in power-factor obtained by increasing the energy load by increasing the losses in the system simply means an increased load on the entire system with no compensating advantage.

"Application of Synchronous Motors to Power-Factor Correction.—Enough has been presented to show the desirability of operating a system at high power-factor. But many classes of load, particularly constant-current transformers for series arc lamps and small induction motors, particularly when un-

derloaded, have inherently a low power-factor, on account of their inductive effect, due mainly to magnetizing current; and with such loads, high power-factor can only be obtained by adding to the system an additional source of magnetizing current that will supply magnetizing current to the inductive apparatus. The synchronous motor presents a practicable means for raising the power-factor in this way. That central station managers recognize the value of the synchronous motors in this field is shown by the increasing use of synchronous motors in motor-generator sets, in industral applications that require large units, and, in particular cases, by their use running without energy load, and entirely for their corrective effect, as synchronous condensers.

"Where there is a suitable load for a synchronous motor there is now very little question regarding the advisability of its installation in cases where improvement in power-factor is a consideration. The similar use of over-excited synchronous motors, running without load as synchronous condensers, is not so generally recognized as justifiable. The expense connected with their installation is easily seen, while the benefits to be derived are not so obvious.

"There are three cases, however, in which the use of synchronous condensers can be shown to be good practice:

"1. In existing systems that are up against trouble due to low power-factor, which can be remedied only by the installation of synchronous condensers. This is, obviously, no case for argument. This is, undoubtedly, the first field that the synchronous condenser will occupy and, in fact, the synchronous condenser is already in the field—two large installations, at least, being under construction.

"2. In proposed systems which will have a large inductive load and in which the investment for feeders and transforming apparatus will be a large proportion of the total cost.

"3. In proposed systems which will have a large inductive load and in which slow-speed generating units—such as gas-driven units—will be used.

"The field of application of the synchronous condenser will be largely confined to these three cases. Under all other conditions the additional capacity made necessary by low power-factor can be most economically provided by increasing the size of the main generators and other electrical apparatus, so that the entire system, engines, generators, transformers and feeders, will be proportionately loaded at the power-factor at which the system will operate.

"Before it can be shown why the use of synchronous condensers is justifiable under the above conditions it will be necessary to review the principles involved in the operation and application of over-excited synchronous motors.

"The action of the over-excited synchronous motor in raising the power-factor of a circuit may be looked at from two points of view. It may be considered that the over-excited synchronous motor furnishes directly the magnetizing current required by the inductive load must be supplied by the main generator, and all the line between the generator and the inductive load, as well as the generator itself, will be loaded up with this magnetizing or wattless current (so called because it represents no energy and does not affect a wattmeter reading). Now, assume that the synchronous condenser is in proper operation. Then this magnetizing current is furnished by the synchronous condenser and only that part of the circuit, in addition to the synchronous condenser, between it and the inductive load, carries the magnetizing current; and, provided the synchronous condenser is located near the inductive load, practically all the circuit, as well as the generator, is relieved of the wattless current. An important point is clearly brought out by this illustration. Adding the synchronous condenser to the system does not eliminate the magnetizing current entirely from the circuit. It is simply transferred from the generator to the synchronous condenser. As long as an inductive load is connected to the circuit its wattless current must be supplied from some source in the circuit. Whether it can be most economically supplied by the main generator or by an auxiliary source of magnetizing current, such as a synchronous condenser (in other words, whether the use of a synchronous condenser is justifiable), depends on the additional generating capacity required in the two cases, on the cost of this additional generating capacity (which is largely determined by the relative permissible speeds) and on the saving effected by eliminating the wattless current from the feeders and intermediate transforming apparatus.

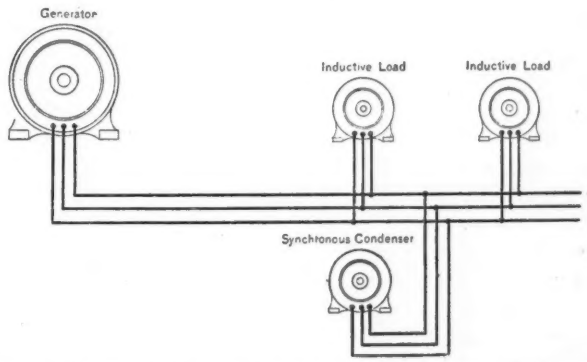

Fig. 1—Diagram of Circuit Containing a Synchronous Condenser

"The second way of considering the action of the synchronous condenser involves the conception that each piece of apparatus connected to the circuit takes a certain current from the generator, each current having a certain power-factor—or phase relation to the voltage—depending on the properties of the particular apparatus involved. In parts of the circuit in which several of these individual currents exist the total current is the resultant of the several currents. In order to calculate this resultant current each individual current is resolved into two component currents—one in phase with the voltage, which represents energy, and the other at right angles to the voltage, which is the wattless current. In inductive apparatus, such as induction motors, this wattless component is in one direction from the voltage and is said to be lagging, while in apparatus having the opposite effect—that of capacity—the wattless component is in the opposite direction from the voltage and is said to be leading. Over-excited synchronous motors have this effect of capacity and their watless currents are leading. In circuits containing several currents, the total current is the resultant of all the separate components of all the individual currents. All the energy components add directly; the wattless components add or subtract, depending on whether they are lagging, due to inductive loads, or leading, due to capacity loads. That is, when leading and lagging components exist in the same circuit, they

neutralize each other more or less completely, depending on their relative values, and when they are equal they completely neutralize each other and the effect is the same as though neither were present. In this case the total current is equal to the sum of the energy components and the power-factor is 100 per cent. Synchronous condensers, then, introduce leading wattless currents into the system that neutralize the lagging or inductive wattless currents due to inductive loads. Referring again to Fig. 1, between the generators and the synchronous condenser, the magnetizing or inductive current due to the inductive load, is neutralized by the leading current due to the synchronous condenser. It is seen that this analysis leads to the same result as when it is considered that the synchronous condenser directly supplies the magnetizing or lagging wattless current. The first way of looking at the action of the synchronous condenser is simpler and more direct; it is therefore better adapted to purposes of explanation and analysis. The second way, while more complicated, leads directly to the method used in calculating."

Mr. Newburry then gives a number of calculations, showing the bad effect of underloaded induction motors, the value of over-excited synchronous motors and the proper size of motor to use to obviate a given inductive effect in order that the generator may be made of smaller size to take care of a given useful load. Besides the lower cost of installation and improved regulation, Mr. Newbury says: "There is another condition under which the use of synchronous condensers may be justified by decreased investment. This is in cases where a large proportion of the investment is in transformers and feeders. The synchronous condenser not only relieves the generators of the magnetizing current, but relieves the feeders and intermediate transforming apparatus. That is, with synchronous condensers, the greater part of the electrical apparatus can be of smaller kilovolt-ampere capacity than when all the system operates at a low power-factor. In cases where the transmission and transforming apparatus form a large proportion of the total electrical apparatus the saving in this part of the system alone may easily pay for the synchronous condensers. This assumes that the synchronous condenser is located as near the cause of the low power-factor as possible, so as to eliminate the magnetizing current from as much of the circuit as possible. The ideal condition is to divide the synchronous-condenser capacity into a number of units distributed throughout the system at the various centres of inductive load.

"A very valuable property of the synchronous condenser will merely be referred to. By means of it the voltage at any point of the system where it may be installed can be maintained constant within certain limits. That is, the synchronous condenser will act as a voltage regulator. This requires that the synchronous condenser be sufficiently large, in proportion to the inductive load, to more than supply the magnetizing current so that the current between the synchronous condenser and the generator will be leading. By varying the field current of the synchronous condenser the voltage at the condenser will be varied, provided there is reactance in the circuit. The field current may be varied automatically, to maintain constant voltage, by a Tirrill regulator. This is very similar to the compounding action of compound-wound rotary converters.

"In laying out a new system, or a new feeder circuit or substation in an old system, in which it is proposed to raise the power-factor by synchronous condensers, difficulty will usually be experienced in estimating the probable power-factor of the new circuit. In such cases the following approximate figures for typical installations may be of service:

"Incandescent lighting, with small lowering transformers, approximate power-factor 93 per cent.; series arc lighting with constant current transformers, approximate power-factor from 50 to 80 per cent.; induction motors, approximate power-factor from 60 to 85 per cent.

"The synchronous condenser has been considered, up to this point, entirely in its relation to the system. There are various distinctive qualifications that it should possess, which will now be discussed.

"The synchronous condenser operates at practically zero power-factor, leading, the only energy component, being its losses. It should, therefore, be rated to carry its normal current at normal voltage and at zero power-factor with the desired temperature rise. Operating at zero power-factor, leading, it will require a large increase in field curent beyond the no-load field current. The necessary margin in exciting voltage should, therefore, be provided.

"There being no energy load, the speed may be chosen to suit the electrical conditions. At first thought it would seem that the speed should be as high as the frequency will permit. The most favorable speed, however, is lower than this. On account of the high field current required, caused by the zero power-factor, the field windings become one of the first limitations in the design. A large field loss requires, relatively, a large number of poles to dissipate it, and the speed must be reduced in order to obtain the necessary number of poles.

"The conditions of operation of the synchronous condenser are favorable to starting directly with alternating current in the armature winding. Whether or not this method can be used is determined almost entirely by the drop in voltage in the system caused by this method. This is determined largely by the relation between the size of the synchronous condenser and the generating capacity. If the capacity of the generators is several times the capacity of the condenser and exact voltage regulation is not important, there should be no difficulty in starting the synchronous condenser direct. When so started it will require from one to one and one-quarter times its rated kilovolt-amperes for starting. This starting current will have a power-factor of about 30 per cent. If the line conditions are such that this starting current is not permissible an induction starting motor may be used.

"The electrical proportions and operating conditions require good damping characteristics to prevent hunting. The necessary damping can in some cases be obtained by using a short-circuited cage winding on the synchronous condenser revolving part similar to the cage winding of an induction motor. When this cage winding is used for its damping properties it should be made of relatively low resistance. This is antagonistic to low starting current. That is, if good dampers are provided the starting performance must be sacrificed. In most cases, however, it is better to insure good operating characteristics by using low-resistance dampers and to let the starting performance suffer to that extent."

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Carbon deposit in the combustion chamber of gasoline engines indicate the use of poor gasoline or poor cylinder oil.

INDICATOR SPRINGS

Comparison of the Single Coil and Double Coil Types and Methods of Construction

By A. C. Lippincott.

While most engineers are familiar with the uses and construction of the indicator, there is one feature about it which is often overlooked, and that is the spring which registers the proper pressure of the cylinder of the engine on the indicator card. We will now give a little information concerning the

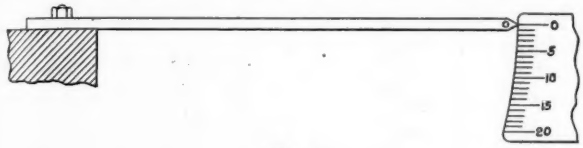


Fig. 1

question of springs, and desire it to be understood, that being for purpose of comparison, the figures given are not exact and are only intended to give a general idea of the subject which is an intricate one, if all the details are gone into.

The simplest type of spring is shown in Fig. 1, and consists of a strip of steel bolted securely at one end to a suitable support, and having the other end free to vibrate. Should any force be brought to bear upon the free end it will bend as shown in Fig. 2. An eight-pound weight is shown attached to the end of the spring, and, as will be seen, causes a bend-

Fig. 2

ing effect which serves to bring the point of the spring to the eight-pound mark on the scale. Referring to Fig. 3, it will be seen that a 15-pound weight will bring the end of this spring down to the 15-pound mark on the scale, and so on, in proportion. In a straight spring of this type, the resistance depends upon the shape of its cross-section; in other words, should this strip be made wider and thicker, it would require more weight to bend it the same distance. If it is assumed that the spring, as shown in Fig. 1, is shortened and the scale moved inwardly, so as to bring the graduations close to its

Fig. 3

end, it will be found that a 15-pound weight will not bend the spring as much as it did before; from these experiments it can be seen that not only does the cross-sectional area of the spring affect its strength, but that the distance between the point of support and the point of attachment of the weight has a great influence. For example, take a coiled spring, as shown in Fig. 4, which is wound with one-quarter inch wire and has a pitch of one inch. The external diameter of this spring is two inches and its length six inches. In Fig. 5 another spring is shown exactly the same in every respect, except that the external diameter is one and one-half inches, and a test will show that this spring is very much stiffer than the one previously mentioned.

If the spring, as shown in Fig. 5, has one coil cut off, so that the length is four and one-half inches, it will be found that this increases its stiffness still further; but if this spring had been shortened by winding it on a mandrel of finer pitch, so that the same length of wire was included, the stiffness of the spring would have been practically unchanged. If another spring be constructed, Fig. 7, exactly the same as in Fig. 6, that is, four and one-half inches in length and one and one-half inches in external diameter, but of one-eighth inch wire instead of one-quarter, this spring will be found to be very much weaker than that shown in Fig. 6.

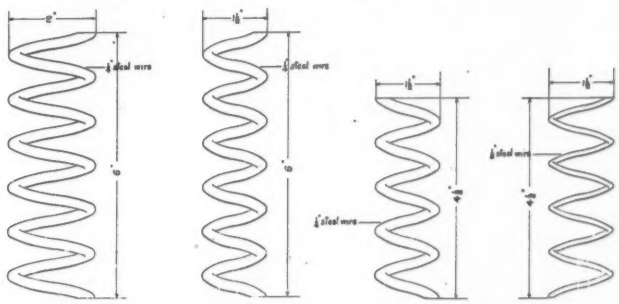


Fig. 4 Fig. 5 Fig. 6 Fig. 7

From these experiments it is learned that the deflection of the spring is governed by several factors, (1) by the diameter of wire used; (2) by the pitch of the mandrel upon which it is wound; (3) by the length of wire included in the spring, and (4) by its external diameter.

The question of springs has been given much attention for indicator work and most manufacturers have concluded that the spring shown in Fig. 9 is preferable for this work. This type is termed the "single coil" spring and is adopted for use in indicator work by providing at either end a suitably threaded head. For appearance sake, and for the convenience of the manufacturer, this head is usually made with four wings, each one having a hole drilled to receive the wire, and these holes must, of course, be properly spaced by advancing them exactly the same distance as the pitch of the spring. It is also necessary to drill these holes at the proper angle, so that the wire will be supported as well as possible.

It will be remembered from the preceding experiments that the length of the spring had much to do with its deflection, and this principle has been made use of in constructing indicator

springs. The top head is left loose upon the coils until a test has been made to determine its deflection. Should the spring be too "weak" the head is screwed further down on the coils, and if too "strong," it is turned in the opposite direction, thus lengthening it or shortening it. Under improved methods of manufacture it requires but a slight amount of time to find the proper point to place this head, and when this point is found, a little solder makes it secure. After the proper adjustment is made, the top of the head is faced off to bring the spring to the proper length "over all." It is customary, with

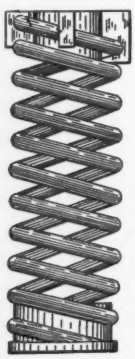


Fig. 8

Fig. 9

each make of indicator, to have a certain length for high pressure springs and to make the low pressure springs shorter, so that the pencil will set higher on the drum, to enable the engineer to indicate engines under vacuum.

It has been thought by some that the single coil spring is not properly balanced and that it has a tendency to cramp in the cylinder, but this is not the case. In order to obviate this imaginary defect, the spring known as the "double coil" type, as shown in Fig. 8, was brought out. This consists of two single springs combined, it being thought that one would balance the other and cause a more even action. To illustrate the action of a double coil spring refer to Fig. 10, in which there is shown two flat strips of steel, each fixed at one end and some distance apart. The free ends of these springs are

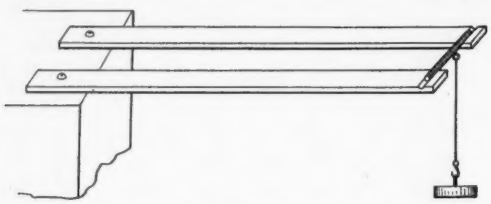


Fig. 10

shown grooved to receive a cross bar for the attachment of a weight. Should these springs be alike in every respect, a weight applied at a point exactly in the centre would depress each one exactly the same distance. Should one of these springs differ in any particular from the other, this spring would not travel in unison with the other and an uneven effect would be produced. Under these circumstances it would be easy to grind one of the springs, and by frequent testing, to balance them perfectly. This might also be done with the double coil spring, but for the fact that they must be combined and firmly fixed in place with respect to each other, before testing. It is therefore an almost commercial impossibility to make a double coil spring so that each coil will be perfectly balanced.

Another illustration is shown in Fig. 11, in which two double coil springs are supported on steel balls, which in turn support an equalizing lever, as shown, and to the center of this lever a weight rod is attached by a swiveling connection. These two double springs are shown with one coil removed from each, for purpose of the experiment. Should these springs be exactly uniform, they would be depressed an equal distance should any weight be applied, but if any variation existed, an

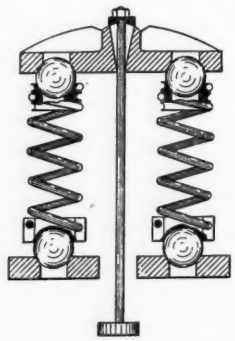


Fig 11

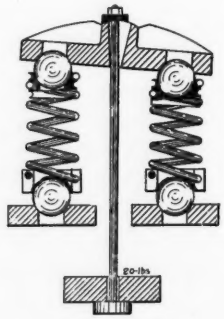


Fig. 12

effect as shown in Fig. 12 would be noticed. Another experiment which requires the use of a small lathe, an indicator spring and two small steel balls having "centres" provided, is shown in Fig. 13. By slowly compressing the spring, it will be noticed that the single coil may be brought "coil to coil" without the slightest tendency to cramp sidewise, while with a double spring, the result as shown in lower illustration of Fig. 13 may be noticed.

There is no doubt that indicator springs built on either plan have been used with great satisfaction, but in selecting a spring it should be remembered that while the double spring may be perfectly accurate, the single coil spring is sure to be. The single spring may be wound with more coils to the inch than the double, and its elasticity is not so liable to be impaired

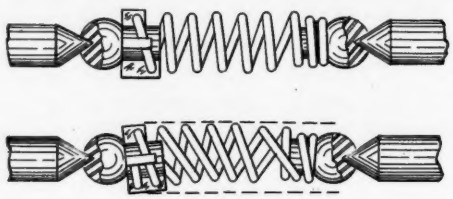


Fig. 13

should it become necessary in a case of emergency to indicate an engine with a given spring, at a higher pressure than is advised.

Indicator springs should bear the following tests before leaving the factory: in the first place, a spring should not show any evidence of warping, due to the hardening process; it should stand compression to at least twice its normal extreme of movement, and return without changing its length over all; it should then be placed in a machine and compressed and extended several thousand times, and should then show no defects or lost motion. Springs properly made and subjected to the above test should never break.

Development of Hydraulic Turbine Sizes

13,500 Horse Power Turbine for McCall Ferry Power Plant Largest ever Built

Within the last four years the science of turbine design and construction in this country has made greater strides in its progress than during any previous period of ten years. It is the tendency nowadays to install a few turbines of high power rather than a great number of small units. This is clearly shown by the following developments which are among the most prominent contracted for during the last few years:

Two units of 6,000 horse power each for the Shawinigan Water & Power Company; eight units of 6,000 horse power each for the St. Lawrence River Power Company; five units of 6,625 horse power each for the Aluminum Company of America; two units of 8,000 horse power each for the West Kootenay Power & Light Company; six units of 10,000 horse power each for the Niagara Falls Hydraulic Power & Manufacturing Company; one unit of 10,000 horse power for the Seattle & Tacoma Power Company; two units of 10,500 horse power each for the Shawinigan Water & Power Company; three units of 12,500 horse power each for the Great Northern Power Company; four units of 13,000 horse power each for the Electrical Development Company of Ontario; six units of 13,500 horse power each for the McCall Ferry Power Company.

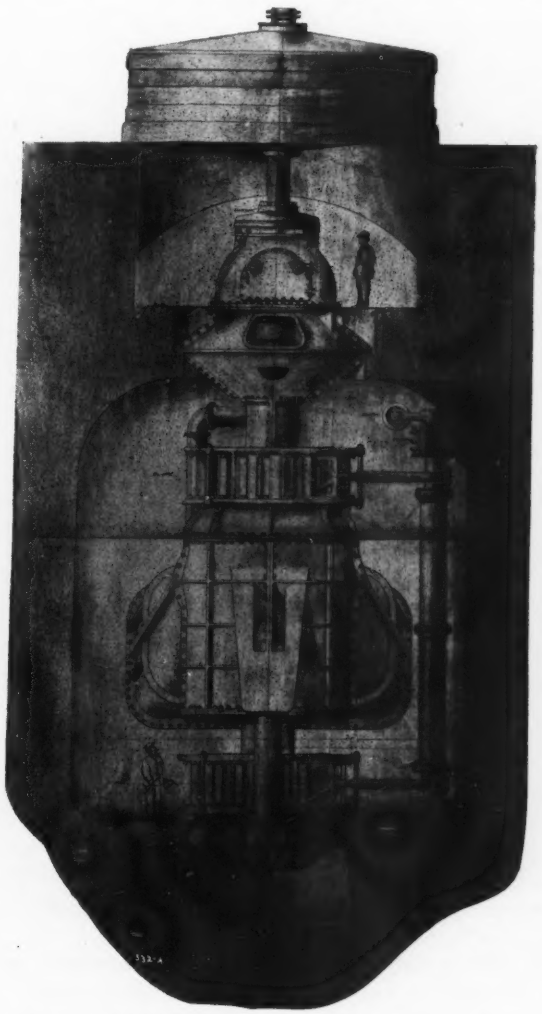
Up to the present time these 13,500 horse power turbines are the largest ever built, and the total development at McCall's Ferry, Pa., when completed, will consist of ten units of 13,500 horse power each. Six of these units are now in course of construction in the shops of the I. P. Morris Company, which is a subsidiary company of the William Cramp & Sons Ship & Engine Building Company. These turbines are designed to operate under an effective head of 53 feet of water and to run at a speed of 94 revolutions per minute, and will be installed in the power house located at McCall's Ferry, on the Susquehanna River, Pa.

The largest turbines in actual operation at the present time are the 13,000 horse power turbines in the plant of the Electrical Development Company. They operate under a head of 135 feet of water and on a basis of 80 per cent. efficiency, each unit requires 1,060 cubic feet of water per second. The McCall Ferry units each require 2,800 cubic feet of water per second to develop 13,500 horse power on a basis of 80 per cent. efficiency.

By comparing the largest units now in operation with those being installed at McCall Ferry, it can be seen that these latter turbines must take care of nearly three times the volume of water required by present largest turbine. Two thousand eight hundred cubic feet of water per second is equivalent to the flow of a river 200 feet wide, seven feet deep and flowing with a uniform velocity of two feet per second.

The McCall Ferry turbines, as shown in the accompanying illustration, are of the inward flow Francis type, consisting of two cast iron runners mounted on a vertical shaft. They are set in concrete pits, with shafts extending up to the power house floor, where they are coupled to the electrical generators. Both runners discharge downwards, the upper one into a cast iron draft chest and the lower one into a concrete draft tube.

In order to reduce the hydraulic thrust of the runners to zero, the chambers above the runners are by-passed to the draft tube. This relieves the pressure which builds up in the chambers from leakage passing around the bore of the runners. By this method the thrust bearing, which is located directly below the generator, will only have to carry the weight of the rotor of the generator and the revolving parts of the turbine. The thrust bearing, however, is designed to take care of a liberal amount of hydraulic thrust over and above the dead weight of the revolving parts.



13,500 H. P. Turbine for the McCall Ferry Power Co., McCall Ferry, Pa.

The thrust bearing consists of two discs, the upper or rotating one being secured to the shaft, while the lower or stationary disc is secured to the turbine machinery. Oil is forced between these discs under a pressure of 250 pounds per square inch. The revolving parts, which weigh in the neighborhood of 340,000 pounds, are thus lifted and are supported on a film

of oil. The oil pumps are capable of delivering the oil at a pressure of 500 pounds per square inch if required.

The water is distributed to the runners through the cast steel movable guide vanes, each vane being connected to the operating rings by links. The operating rings in turn are joined to the operating shaft by connecting rods. Thus the governor which controls the operating shaft will open and close the gates as the load on the generator increases or decreases.

For the future, designs of still larger turbines are being completed, and if the plans mature, three units of 18,000 horse power each will be used by the Great Western Power Company. These units will operate under a head of 525 feet and will run at a speed of 400 revolutions per minute.

SANITARY HYDRO-ELECTRIC STATION

Power Plant to Operate in Connection with the Chicago Sewerage System

One of the largest power transmission plants in America is now being installed near Lockport, Ill., by the Sanitary District of Chicago. This power development will ultimately reach an output of 40,000 horse power, with half that amount of power available at a very early date.

The hydro-electric plant is located about thirty miles southwest of Chicago and somewhat less than two miles south of Lockport, Ill., the municipalities within the limits of the Sanitary District being supplied first with electric current after which the surplus power, of approximately 10,000 horse power will be sold to power users in general at a price lower than the price of steam power.

Fig. 1—Construction of Head Race, Chicago Drainage Canal

The Sanitary District of Chicago has expended more than fifty million dollars during the past decade in the construction and maintenance of the drainage canal, and recently the engineers planned this great hydro-electric power station for taking advantage of the large flow of water in the canal for electric power transmission purposes.

The accompanying illustration, Fig. 1, shows recent work on this hydraulic development which was started three years ago, while illustration, Fig. 2, shows the power house under construction, and Fig. 3, the 6,000 horse power turbine units which will take advantage of the 34-foot fall available.

The accompanying illustration, Fig. 4, shows one of the eight 4,000 kilowatt alternating-current generators for direct connection with the water wheel. There are four of these generators and two exciter units now being installed in the power house of the Sanitary District, with provision for additional units when found necessary.

The power house near Lockport is of fireproof construction, being built of steel and cement blocks on solid rock foundation. The building is 385 feet long and 47 feet high, with a total width of 70 feet, the dam across the channel being formed by the power house itself, the controlling works and the ship block, the movable crest dam or controlling works joining the power house to the east. The lock is large enough to admit the greatest river steamers afloat, with concrete walls 52 feet high at the lower end of the lock. For protecting the forebay from floating ice, a concrete guard is built across the channel, this wall diverting the ice to the controlling dam. There are a series of iron racks provided, extending along the entire length of the power house, to protect the wheel chambers from floating material which might pass the ice guard.

Fig. 2—Chicago Drainage Canal Power House

The 6,000 horse power turbine wheels are being constructed by the Wellman-Seaver-Morgan Engineering Company, of Cleveland, designed to operate at a speed of 164 revolutions per minute under a head of 34 feet, the retaining walls of the channel being 40 feet high and bringing the water level near the top of the building on the receiving side. As noted in the illustration, these water wheels are located in the turbine chambers at the floor level and discharge through the chambers to the tail race. There are two exciter water wheels of 600 horse power each, directly coupled to exciter dynamos of 250 kilowatts capacity.

The alternators of 4,000 kilowatts output are being constructed by the Crocker-Wheeler Company, and are of the 44-pole revolving field type, generating a three-phase current of 6,000 volts pressure, with a frequency of 60 cycles per second. The alternating current from these generators is raised in pressure to 44,000 volts for transmission a distance of thirty miles, to the Chicago sub-station, where it is transformed down to 12,000 volts for distribution. The sub-station

is 124 feet long and 42 feet high, with a total width of 70 feet. It is located at West Avenue and the Canal, and is equipped with the usual switchboard, transformers and measuring instruments. From the Chicago sub-station, which is equipped with three-phase oil-cooled transformers of the General Electric type, the current is conducted to the commercial power users, where it is reduced again in pressure. It is also utilized for commercial electric lighting, as well as for street lighting in the city of Chicago.

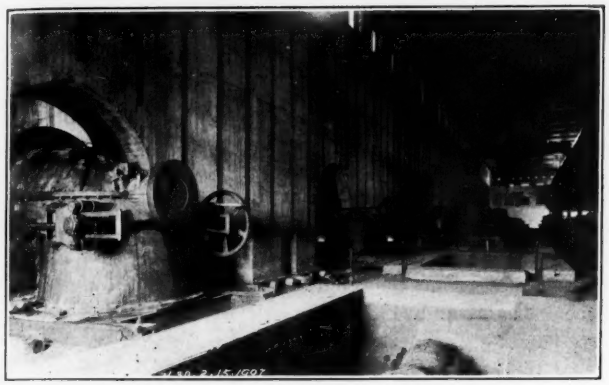


Fig. 3—Interior of Chicago Drainage Canal Power House.

The transmission lines from the Lockport hydro-electric station to the Chicago sub-station include two circuits of aluminum conductors mounted on high-tension insulators of special construction supported on galvanized steel poles 60 feet high, provided with concrete foundations.

The cost of the hydro-electric power development at Lockport, Ill., on the drainage canal, will exceed three million dollars, but it is stated that, considering the amount of power developed, the existing conditions are so favorable that the cost of development is exceedingly reasonable and permits of the power being sold at a very low rate, while it is also maintained

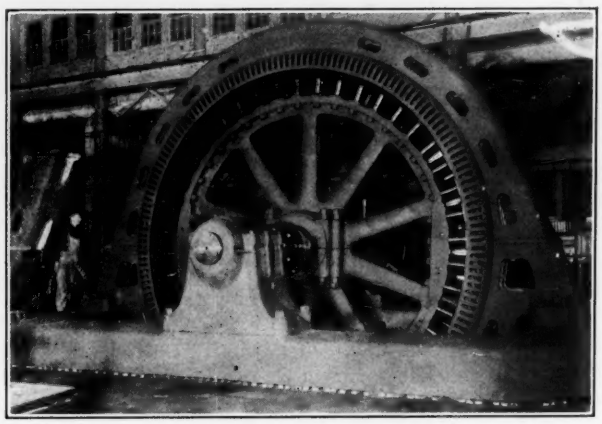


Fig. 4—4000 K. W. 3-phase Alternator for the Chicago Drainage Canal Power Plant

that the natural condition of the water supply, together with the care used in the construction of the generating and transmission installation assures a satisfactory and constant service. Mr. Edward B. Ellicott, who is electrical engineer of the Sanitary District, has had charge of the installation of this electric generating plant.

Sites adjacent to the canal at points convenient for supplying the power will be leased by the Sanitary Company, with water for all uses of these industries, and electric power will be available at an early date at any point along the canal between Roby Street and Lockport, as well as other locations at a considerable distance away.

The drainage canal was planned for sanitary purposes and is now completed to Lockport, with extensions under way beyond Joliet, Ill. It was planned to care for the sewerage system of Chicago in order that the Lake Michigan water supply should not be contaminated, and permission was obtained at Washington to reverse the flow of Chicago River, diverting 10,000 cubic inches of water per second.

Low Power Rate for Canadian Towns.

As a result of the campaign which has been conducted by the municipalities of Western Ontario for the control of a portion of the power output of Niagara Falls, the Ontario government has just closed a contract with one of the generating companies by which power will be supplied to these towns at a very low figure. The company is to supply 35,000 horse power at the rate of $10.40 per horse power per year. This is said to be the beginning of a comprehensive scheme of Canadian government control of Niagara power, it being intended that ultimately the government shall control the power product of the Falls in order to curb the commercialism which might tend to impair the scenic value of the Falls.

The Supply of Air for Combustion.

For supplying air for the combustion of fuel, a fan blower varies in type according to the character of the furnace. For the production of mechanical draft for steam boilers, under either the forced or induced draft system, the fan may be of ordinary steel plate construction, designed to operate at a maximum pressure of from one to one and one-half ounces per square inch. Here the fires seldom exceed ten inches in thickness. On the other hand, in the foundry cupola with its superimposed charges of fuel and iron aggregating ten to fifteen feet in depth, a pressure ranging from eight to possibly sixteen ounces per square inch is essential to compel the passage of the air through the tortuous channels formed by the mass of material within. The total quantity of air required under these conditions is relatively small, while the type of fan is distinctive, being narrow, of high efficiency and maximum durability, but of only moderate volumetric capacity.

The bursting of a large fly-wheel at the Frost & Van Riper's silk mill, at West Pittston, Pa., badly wrecked the main building and injured two employes. A 500-pound section of the wheel passed upward through the first and second floors and the roof, and then dropped back in another portion through the roof and two floors to the cellar.

The bursting of a large fly-wheel at the Creighton Power Plant at Tarentum, Pa., near Pittsburg, on June 2, instantly killed Frank M. Geiger, engineer, and seriously injured Calvert Hazlett, assistant engineer, and several other employes. The building was wrecked and the street car service on all lines around Tarentum was suspended for twelve hours.

BALANCING SETS VS. 3-WIRE DYNAMOS

Economy of Installation, Simplicity of Connections and Advantages of Operation on a 3-Wire System

About three years ago the three-wire generator began to be introduced in power plants, to take the place of the two dynamos connected in series, and since that time it has had more or less extended use throughout this country. The three-wire generator is a direct-current dynamo, giving the full over-all voltage at the brushes, and having a third terminal which is connected to the neutral of the three-wire system. This third terminal is connected to the middle point of an auto-transformer, or balancing coil, the terminals of which are connected to points of opposite potential in the armature winding of the generator. With this arrangement it is claimed that all the functions of two dynamos with a motor-balancer will be met, but only within limitations is this true.

In the early days of electric lighting the three-wire system of distribution was developed and widely used as an economical arrangement of low potential circuits. For a given voltage at the lamp, it reduced the cost of copper installed almost two-thirds, as it permits the transmission and distribution of the greater part of the current required at a potential approxi-

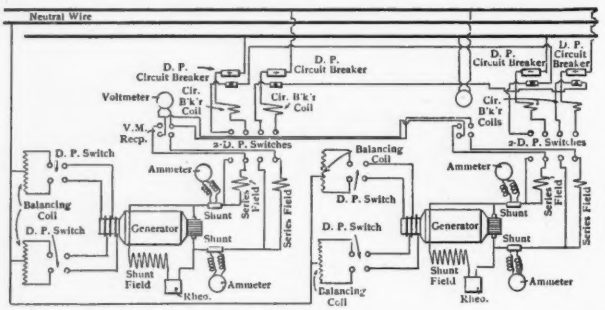


Fig. 1

mately double that maintained at the lamp, the third or neutral wire carrying only the difference between the currents on the two sides of the system. The original arrangement included the use of two generators connected in series, each wound for the potential required by the lamps, the neutral wire being led from the point of connection of the two machines. At a later date, a modification was introduced in the form of balancing sets, consisting of two machines coupled together and so connected across the lines that the machine on the lighter loaded side of the system operates as a motor and drives the other as a generator, thus developing the current necessary to provide the excess load and balance the system. Such a combination of machines is known as a "motor-generator," or balancing set.

The introduction of the three-wire generator has done away with the use of the motor-generator set, as the balancing coil, with which it is equipped, acts exactly like the balancing set. The complication of connections, however, which arise when three-wire generators are run in parallel is shown in Fig. 1. Equalizer wires are run from both positive and negative terminals of the armature winding. The balance coils are usually connected to the collector rings through switches, the neutral wire only being taken to the switchboard. That the voltage between the neutral wire and either generator is half that of the generator can be understood by referring to Fig. 2, which represents diagrammatically the armature winding of a bi-polar generator connected to one balance coil. The direct-curent brushes are represented at the points A and B. The balance coil is permanently and symmetrically connected at the points C and D, dividing the armature winding into two equal parts. The neutral wire connects at the point E, the mid-point of the balance coil. Windings and connections being symmetrical, it is evident that when the terminals of the balance coils are directly under the brushes, that is, when the point D coincides with the point A and the point C with the point B, the balance coil is subjected to the full voltage of the generator, and the potential between the mid-point E and the brush A is equal to that between E and B, and one-half that between A and B. Correspondingly, when the armature has rotated 90 degrees, so that the points C and D lie directly under the poles, the balance coil is subjected to no difference of potential and the voltage between E and A, and E and B, are respectively equal to the voltages between D and A, and C and B. But since the winding is symmetrical, the voltage between A and D is equal to that between B and C, consequently the voltages are equal between E and A, and E and B. In any other position of the armature the voltage between E and A is the resultant of half the voltage of the transformer coil and that of the armature winding between A and D. Correspondingly, the voltage between E and B is the resultant of that between C and E, and C and B. But as the voltages between A and D, and B and C, are always equal, and E is the mid-point of the balance coil so that the voltage between E and D is always equal to that between E and C, it follows that the voltage between E and A must always equal that between E and B, and that E is therefore the neutral point and may be so used. The same reasoning applies to multipolar generators and any number of balance coils.

In connection with the operation of balancers and three-wire dynamos, Mr. Budd Frankenfield read an interesting paper before the June meeting of the National Electric Light Association, which follows in part:

"Despite all efforts to produce an incandescent lamp of a voltage sufficient to render the operation of two lamps in series unnecessary from the standpoint of economy in copper, the three-wire system is to-day in general service. The recent introduction of metallic-filament lamps of high efficiency, lamps which seem to be inherent'y low at voltage, points, if anything, to a longer lease of life for the three-wire system.

"Like many of the Edison inventions, the three-wire system is a perfect solution of this problem. In all its years of usefulness it has been subject to improvement only in the nature of engineering refinement; namely, its adaption to the needs of colossal undertakings, its submission to the untiring spur of economy. This latter phase is the one with which the present paper has particularly to deal. Any effort to reduce the cost of installation or of operation must meet in addition all

the rigid requirements of regulation and of schematic simplicity so beautifully met by the Edison three-wire system.

"The Edison unit, consisting of two dynamos connected in series, with the neutral wire tapped in at the common point of connection, is of itself a suggestion for a more economical arrangement. Obviously, this unit occupies more floor space than a single dynamo of equal capacity, requires more attention, and in small sizes is less efficient.

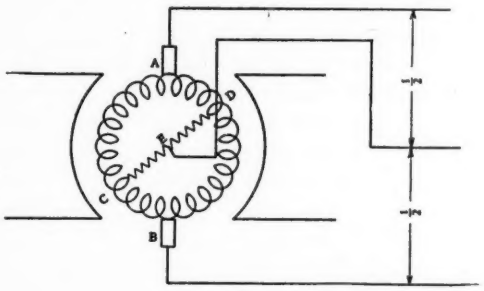


Fig. 2

"Inventors sought for a long time to devise a three-wire dynamo to replace the two machines of the Edison unit. They have succeeded, but within limitations. A few types that have been placed on the market will now be described.

One of the oldest machines (Fig. 3), accredited to Hopkinson, consists of a machine having two equal windings and two commutators. The two windings are connected in series and to the neutral, after the manner of the two machines of an Edison unit. In regulation, this machine has the advantage that any reduction in voltage due to armature reaction affects both windings alike, the only difference being between the two delivered voltages being the excess of resistance dropped in the heavier loaded winding on unbalanced load. The armature must be made longer on account of the two commutators, and the shaft somewhat heavier than in the case of a two-wire machine. This makes the saving in floor space and in first cost less than one's ideal of a three-wire dynamo leads him to expect. Furthermore, it is impossible to regulate the voltages independently except by shifting the brushes—hardly a practical method.

The three-wire dynamo of Dobrowolsky is shown in Fig. 4. A choke-coil is tapped into the armature winding at the two points of opposite potential (assuming bi-polar construction), and the centre of this coil is connected to the neutral wire. If the choke-coil is mounted so as to rotate with the armature, the neutral is connected to the centre of this coil by means of one slip-ring; if mounted in a stationary position, as shown in the diagram, the outside terminals of the coil are connected to the armature through the medium of the two slip-rings and the neutral connection is tapped in solid. The centre of the choke-coil is at mid-potential, and any difference in current between the two branches of the system can flow along the neutral and through the coil, which offers no impedance to direct current. The windings of the choke-coil are arranged so that the direct currents in the coil are magnetically opposed, thus avoiding saturation of the core. This feature is only partially accomplished. An alternating magnetizing current and also an alternating core-loss current are present in the coils, and both these currents increase with unbalanced load because it is not possible to completely eliminate unidirectional magnetization.

Lamme's modification of this invention (Fig. 5) consists in making the slip-ring connection two-phase; there are four slip-rings besides the commutator, and two choke-coils connected in star. The neutral wire is connected to the centre of this star. By this means a slight gain is made in the distance the neutral current must traverse the armature winding.

Both machines, while simple in principle, are sufficiently complicated in the connections to render the locating of trouble an irksome task. In addition, the increased length of shaft required for the slip-rings cuts down the saving in floor space, and it is impossible, without added complication and mechanism, to regulate the voltages independently. An admission of this weakness is evidenced by the fact that two large manufacturers have taken out patents on an additional auxiliary device, practically amounting to a balancer, the purpose of which is ti regulate the two voltages.

The three-wire dynamo of Osana (Fig. 6) is provided with an auxiliary winding laid in the same slots as the main winding, usually in the bottom of the slots. Sections of this auxiliary winding are proportioned to develop opposed voltages of half the value of the main voltage. It is tapped into the main winding at the opposed points of connection, and the centre of each section is connected to a slip-ring, which is in turn connected by a brush to the neutral. If the conductors of Dobrowolsky's choke-coil were placed in slots on the armature surface and connected so as to develop an e.m.f. equal and opposite at every instant to that impressed on the termina's of the coil by the main winding of the armature, there would be no alternating current in the coil and the magnetizing and core loss components would not exist. This, in fact, is the embodiment of Osana's machine. It is said that there is no gain without some sacrifice, and the sacrifice in this case lies in placing the auxiliary winding in the armature slots, the most valuable space in a dynamo. On account of the heating of the auxiliary conductors and the increased slot depth required, it is necessary to make the armature of a machine of this type of increased diameter. The old weakness, lack of independent voltage regulation, is common to this machine also. One attempt has been made to overcome the difficulty by mounting the positive and the negative brushes on independent rockers, and supplying means for shifting these brushes independently.

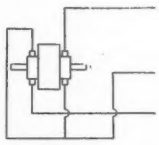


Fig 3

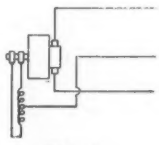


Fig. 4

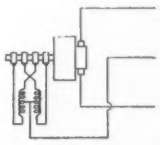


Fig. 5

Imagine the confusion in a station using this system when it becomes necessary to balance the voltages. In a small station the attendant would be kept running back and forth from the switchboard to the dynamo, reading the voltmeter and adjusting the brushes. In a large station, with a switchboard attendant located in a gallery, the amount of signaling to the dynamo man would be prohibitive. Again, in order to regulate the voltages in this manner the machine must be designed with an unusual margin in commutation.

An interesting machine is that of Dettmar and Rothert (Fig. 7). Here a two-pole armature is mounted in a field having four salient poles. Poles of like polarity are situated in juxtaposition, each pair forming a single pole. In reality, the machine is a two-pole dynamo with a wide gap in the centre of each pole. The neutral brush is placed opposite this gap. Armature reaction, even with the balanced load, weakens the upper south pole, and strengthens the lower south pole; likewise, the lower north is weakened and the upper north is strengthened. The result is that the voltage on the positive side of the system becomes lowered and that on the negative side increased. This is overcome by compounding the weakened poles cumulatively and the strengthened poles differentially. This same winding is effective in balancing the voltage automatically. It is also possible by connecting the shunt field coils in two independent circuits to regulate the voltage independently by hand. This machine accomplishes in regulation all that can be done with an Edison unit. The chief disadvantage is its excessive weight, the yoke and the armature core being twice the cross section of an ordinary four-pole machine. If made with more than four poles, the construction is limited to an even number of pairs of poles. An objection to all three-wire dynamos is that in order to compound them so as to deliver the necessary total voltage at any load the series field winding must be divided into two circuits, half the total number of coils being connected in series with each main. The connections for the Dettmar and Rothert machine have just been described. In the other machines the series coils are

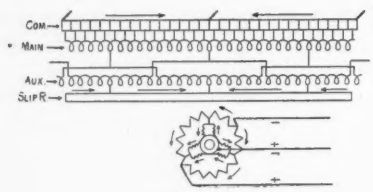


Fig. 6

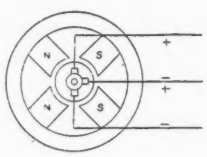


Fig. 7

all made cumulative, and coils that are mounted on poles of light polarity are connected in series with the other leg to connect from coil to coil in either circuit requires a jumper, spanning a complete pole. As stated, this compounds for the total voltage only, and has no effect whatever in balancing the voltage.

To operate two compound three-wire dynamos in parallel, two equalizer bars are necessary, one for each series field circuits. This adds an aditional and expensive feature to the switchboard, and in switchboards of large central stations there would be difficulty in finding room for the extra equalizer. A diagram for multiple operation is shown in Fig. 8. There are six heavy cables of full-load capacity running to the switchboard and in addition there is a neutral cable. In the case of the choke-coil system, the coils are often placed back of the switchboard or at some equally distant place from the machine, requiring in this case four small cables leading from the machine. All of these wires are multiplied for every three-wire machine in the plant; the item of expense is considerable, and should not be neglected when comparing different three-wire systems. One might think that four full current cables would suffice, two for the equalizers and two for the leads. The figure shows that two aditional cables leading from the armature are necessary in order to obtain adequate protection for the machine. These two cables lead to the ammeter shunts and the two circuit-breaker coils. An attempt has been made to avoid the use of these two cables by mounting the ammeter shunts on the terminal blocks of the machine and running long lead wires from these shunts to specially calibrated ammeters on the switchboard. In this case the circuit-breakers are placed in series with the cables leading from the series fields. This is not the place for a protective device, because it is liable to throw the machine out of service when the armature is not at all overloaded; since the coil of the circuit-breaker might be actuated by the sum of the armature current plus an equalizer current from the other machines just at the time when equalization is most needed. In order to get equalization comparable to that of the two-wire dynamos it is imperative to use the six big leads, to each machine.

In order to operate a compound two-wire dynamo in parallel with compound three-wire dynamos, it is necessary to split its series field into two circuits and supply two equalizers. Standard two-wire dynamos must therefore be remodelled to the extent of a reconnection of the series fields and the addition of at least one new terminal block for the extra equalizer. Many machines are so built that it is difficult to make these changes without considerable expense; for example, a machine with rectangular poles having the series coils leads coming out between the poles may require rewinding of the series fields.

The little that is gained over the old Edison system by combining two-wire and three-wire dynamos in one plant is more than lost in the inability to regulate the pressures.

Another difficulty common to all machines with double equalizers is that, unless the machines are fully built up before the equalizers are thrown in, a short circuit of the most violent nature, is likely to occur through the armature of the incoming machine. This is because the equalizers are at the full terminal difference of potential.

Balancers.—The balancer system was devised as a means for supplying a three-wire system from a station using standard two-wire dynamos as the generating units. It is claimed that a station designed on this plan has the advantage in cost and simplicity over a station using three-wire dynamos.

Fig. 9 illustrates the electro-chemical form of balancer. The storage battery not only takes care of the peaks of the load, but may also be used to regulate the voltages. On unbalanced load one side of the battery may be charging and the other discharging, and the voltage may be regulated by shifting the point of connection to the neutral, or preferably by a system of end-cell switches or boosters. The diagram of connections of an actual installation is not so simple as the one shown, owing to the use of boosters and end cells. The battery is too bulky to be used as a balancer alone, its chief function being to take care of the peaks. Like all balancers, the storage battery may be located at a distance from the station, thereby saving in feeder copper.

The dynamo-electric form of balancer may be divided into three classes:

1. Balancers that give balanced voltages only on balanced load. These have the weakness common to three-wire dynamos.

2. Balancers that may be regulated manually to balance the voltages. This class is suitable for central-station duty where

the plant is large enough to require a switchboard attendant. A system of this kind is comparable with the Edison system.

3. Balancers that regulate inherently for balanced voltages under any condition of load. These should be used where there is no attendant and where the unbalanced load fluctuates rapidly over a considerable range.

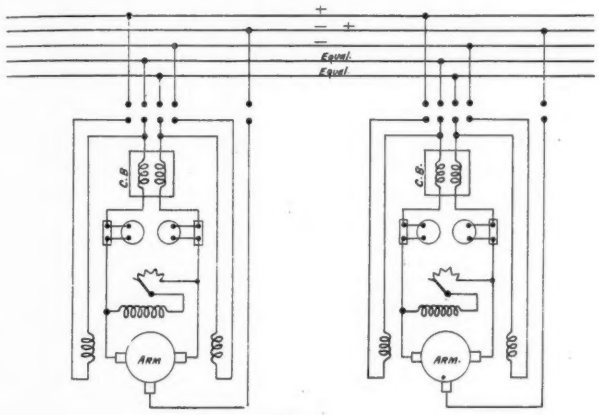


Fig. 8

Balancer Switchboards.—Balancer switchboard diagrams vary considerably with the particular balancer system employed. They may be simple or complicated, depending on the ability of the designer; but in any case the switchboard connections required to take care of a three-wire load are *not* multiplied for every dynamo in the station. They are confined to one panel for each balancer set, and *the cables and other switchboard paraphernalia are limited to a capacity represented by the unbalanced load, or a share thereof.* Several balancers may be operated in parallel when conditions require it.

The chief objects to be kept in view in designing a switchboard panel for a balancer are:

1. Simplicity of operation.
2. Protection of lights.
3. Protection of balancers.

It is possible to arrange the connections so that a balancer may be started up or paralleled by just three operations: (1) closing of a main switch; (2) operating the starting lever; (3) closing the neutral or neutral and equalizing switch.

As to protection of lights, a balancer should not be connected so as to be cut out of service due to overload, without also cutting out the lights; otherwise, the lamps may be burned out or strained, or at least bad regulation will result. A balancer should be built for hard service and should not be cut out for trifling causes. It can be built to stand the rigors of heavy central-station duty, the taking of overloads with good regulation, the burning off of grounds. For this reason protection of balancer is placed as the least important. Keep the lights burning at all hazards and build the balancer to stand the strain.

Rating of Balancers—The logical method of rating balancers is on the basis of neutral current; that is, a 50-kw. balancer operating on a 120-240-volt circuit would supply a neutral current of 417 amperes.

Size of Balancer.—The capacity of a balancer should be based on a certain definite allowable percentage of unbalancing. The value of this percentage depends entirely on the patience and skill exercised in making and studying the service connections. In average practice the capacity in kilowatts of a balancer will vary from 10 per cent. of the total load in a well-balanced installation to 20 per cent. in poorly-balanced ones. Where there is a totalizing circuit-breaker connected in the outside wires, the nominal rating of the balancer need not exceed the anticipated amount of unbalancing, but it should have a good momentary overload capacity.

Where there is no totalizing breaker, the balancer should have a momentary capacity of 25 per cent. more than the largest outside feeder fuse, and in heavy central station work it should be capable of burning off ground. Owing to the multiplicity of feeders, this does not make with the capacity excessive.

Types of Balancers.—An early type of balancers shown in Fig. 10 consists of a motor generator with one armature connected across the mains, and the other between one main and the neutral. The fields were often connected independently across the mains. In this machine the entire amount of power represented by the neutral current must undergo or be the result of a transformation. In the balancer shown in Figs. 11, 12, 13 and 14 only a little less than half the neutral current represents transformed power, and the unit need by only about half the size of a balancer connected as in Fig. 10.

Operation of a Balancer.—Omitting Fig. 10 from further consideration, let us consider the action of a balancer in service. Fig. 15 represents the current distribution system. At no load or balanced load on the system, there is a lost current, *Il,* in the two armatures of sufficient magnitude to supply the stray power of the two machines. As the load becomes unbalanced, say, in favor of the left side of the system, the drop between the upper wires and the neutral due to the low resistance of the load on that side, approaches more nearly to the counter-pressure of the machine G and the lost current becomes unequally divided, decreasing in G and increasing in M by an equal amount. The excess of the loss current in M is supplied by the establishment of a current *Im* in the neutral. A still further unbalancing decreases the loss current in G and

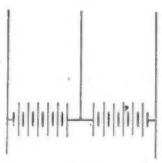


Fig. 9

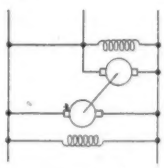


Fig. 10

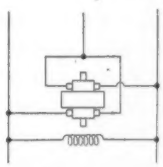


Fig. 11

increases it in M by an equal mount until a point is reached where the loss current in G is zero and machine M carries the entire loss current of the two machines. At this point G is acting as a generator operating on no load, and M as a motor under a load equal to the stray power of G, and the current *Im* is equal to *2Il* of the no-load condition. A further unbalancing establishes a current *Ig,* a generator current eminating from G and increases the current *Im* enough to supply *Ig* and its attendant losses.

Fig. 16 represents this sequence graphically. Motor currents are plotted to the left and generator currents to the right of the zero line. The vertical scale represents watts output of the motor, and watts intake of the generator,

and the horizontal distance between the two curves is the neutral current. In balanced load the distance *Oa* represents the current *Il*, a motor current equal in each machine. As the load becomes unbalanced, the motor current of one machine decreases and that of the other increases an equal amount. Finally at a transmitted wattage between the two machines equal to *Ob*, the armature current of one machine is zero and that of the other *2 Il*, equal to *Im*, which is also the neutral current. A greater unbalancing establishes a generator current *Ig*, as shown. Below the point *b* the neutral current represents the difference between the two motor currents,

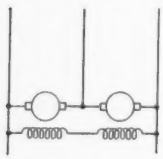


Fig. 12

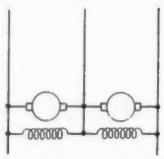


Fig. 13

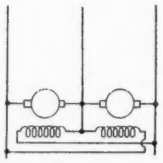


Fig. 14

above *b* it is the sum of a motor current *Im*, and a generator current *Ig*. The generator action on the one side arrests the drop in pressure between the corresponding main and the neutral, and the motor action on the other side has a like effect.

Regulation.—The inherent regulation of a shunt-wound balancer depends upon its field connection. In Figs. 11 and 12 the amount of shifting of the neutral potential from balanced condition is equal to half the neutral current multiplied by the resistance of one armature circuit.

In Fig. 13 there is a variation of field flux with load and the regulation is not so good. In Fig. 14, where the fields are crossed, the regulation is better than in Figs. 11 and 12, and is even better than that of a two-wire dynamo.

Shunt balancers may be regulated manually by field rheostat the same as the Edison unit. The inherent regulation can be made better than that of an Edison unit, and the shunt-wound balancer is recommended wherever there is a switchboard attendant, and for all cases where the changes in load are slow.

Where the load fluctuates rapidly and where there is no attendant, the balancer should be compounded. This is generally done by compounding the motor differentially and the generator cumulatively. The amount of compounding per machine is only about half that of an ordinary lighting dynamo of the same size, and the bugbear of the differential motor disappears, even with large overloads. In fact, it is possible to build a compound balancer so that its speed will be constant up to the burning-out point.

It is interesting to consider the amount of over-compounding to give respectively to the generator and the balancer in order to deliver constant balanced voltages at a centre of distribution when the mains and neutral have an appreciable drop. This is a problem often met. A service that demands a limiting variation in voltage of but 2 per cent. at the lamps must be supplied with balanced voltages at the centres of distribution.

Many central statians in this country have several engine-driven Edison units operating in parallel with two-wire machines of full-line voltage, the Edison units being used to balance the voltage. If these Edison units were disconnected from their engines and coupled up as balancers, the capacity of each unit with respect to neutral current would be doubled, nothing would be lost with respect to regulation, and the engine could be dispensed with.

The economy is still greater when a new lay-out is considered. Fig. 17 illustrates a station which, for the sake of comparison, has been taken at 1,000 kilowatts, 10 per cent. of which is unbalanced load. It consists of a 900-kw. engine and generator and a 200-kw. engine and Edison unit. Fig. 18 represents a balancer system of the same capacity. The main engine and generator are in this case of 1,000 kilowatts. The Edison unit and its engine are dispensed with in this case, and a balancer, consisting of two 50-kw. machines, is used instead. While the electrical portion of the installation aggregates the same in each case, the balancer can be operated at a higher speed than the Edison unit, and there is a saving in first cost of engines, foundations and floor space.

Continental practice favors the balancer system. While it has also been used freely in this country, we have of late experienced a fad in three-wire dynamos, which the dictates of good engineering will not permit to endure.

In conclusion a comparison of the three-wire dynamo with the two-wire dynamo and balancer may be summarized as follows:

1. The three-wire dynamo cannot be regulated for equal voltages; the balancer can.

2. The balancer can also be made to regulate inherently for equal voltages; the three-wire dynamo cannot.

3. The balancer is capable of carrying a neutral overload with good regulations; the three-wire wire can carry it, but only with poor regulation.

4. The three-wire dynamo represents extreme specialization in design. This means long delivery when in a hurry to increase the size of a plant. It means delay when it becomes necessary to make repairs. The two-wire plant with a balancer consists of standard apparatus throughout. This means quick delivery and quick repairs.

5. The three-wire dynamo has complicated connections repeated for each unit in the plant; this makes it difficult to locate

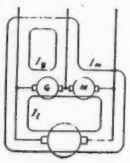


Fig. 15

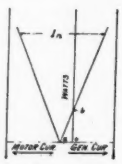


Fig. 16

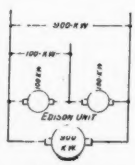


Fig. 17

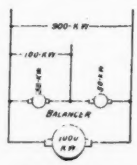


Fig. 18

trouble. The connections of a two-wire plant using a balancer are simple and easy to understand. Trouble is easily located.

6. The three-wire dynamo requires expensive switchboard connections and a lot of heavy cables. The two-wire plant, with balancer, does not.

7. A two-wire dynamo will not operate successfully in parallel with a three-wire dynamo without remodelling. Any number of two-wire dynamos can be aded to a two-wire plant with balancer without making a single change in their construction.

8. There is danger of a violent short circuit when a three-wire dynamo is brought up to speed and paralleled. This danger does not exist in equalizing a two-wire dynamo or in equalizing a balancer.

9. A three-wire dynamo requires two double-pole circuit-

breakers. The two-wire dynamo requires but one. The balancer requires but one.

10. The three-wire dynamo plant requires two equalizers. The two-wire plant requires one, and when compound balancers are operated in multiple the equalizer outlay for this portion of the plant is insignificant.

11. The three-wire dynamo plant requires two ammeters for each machine. The two-wire plant with balancer requires but one ammeter for each machine and one for the balancer.

12. The balancer can be located at a distance from the station. The three-wire dynamo must reach out from the station to the distant point.

13. Lastly, it should be emphasized that the balancer is not limited to isolated-plant service, but is capable of much heavier duty.

Hydrostatic Test of a Horizontal Return Tubular Boiler

Results Obtained After 20 Years of Service

A few weeks ago, after twenty years of continuous service, a horizontal return tubular boiler was removed from the box shop of Frank P. Cheney at Lowell, Mass., and subjected to various hydrostatic tests to determine its deterioration, if any, and its ultimate strength.

The boiler was installed in 1887 by the Scannell & Wholley boiler works, also of Lowell, and had the following dimensions:

Boiler shell made in three course with single plates.	
Diameter of boiler	66 in.
Average thickness of plate as measured from dry sheet	.3885
Length of boiler over all	16 ft. 6½ in.
Length of tubes	15 ft.
Diameter of tubes	3 in.
Number of tubes	120
Kind of joint	Lap
Number rows of rivets	2
Diameter of rivets	¾ in.
Diameter of rivet hole	13-16 in.
Pitch of rivets	2⅜ in.
Number of diagonal bar braces in each end	1
Number of head to head braces	6
Diameter of braces	1.25 in.
Tubes in front head expanded.	
Tubes in rear head beaded.	
Tensile strength of plates (assumed)	55,000 lbs.

Through the courtesy of Mr. Frank P. Cheney, the owner, Lowell Association, No. 17, of the N. A. S. E., were given the privilege of putting a water pressure on it to see what would happen. So on the afternoon of May 11, everything being ready, about two hundred engineers of Lowell and vicinity assembled at the Scannell boiler works to witness the event.

Chief State Inspector Joseph H. McNeil and Inspectors Ferguson and Hinkley, together with Inspector Molloy, of the Manufacturers' Mutual Insurance Company, and Joseph Jones, a former inspector of the Hartford Insurance Company, were present by invitation of Lowell No. 17, to verify measurements, and get any other data available. National President T. N. Kelsey, and F. L. Johnson, president of the Massachusetts State Association, were interested spectators.

After a short inspection of the boiler works, the visitors and inspectors repaired to the part of the yard where the boiler was in readiness to be operated upon, with a 6" x 2⅛" x 6" Worthington Duplex, outside packed plunger pump connected to it, and Mr. Cooke, the engineer of the F. P. Cheney factory, at the throttle ready for business.

After looking the boiler over carefully, and the inspectors verifying their measurements, Mr. J. J. Markham, chief engineer of the Lowell Electric Light Company, who was in charge of the test, gave the word to the engineer to start the pump, with the following results:

At 125 lbs. pressure by gauge, a stream about as large as a pin-head started on top from the rear girth seam, and a little weaping from the middle longitudinal seam. At 250 lbs. the middle longitudinal seam leaked badly, beginning near the middle and extending each way, and both end plate joints began leaking a little.

A steel tape was passed around the middle plate of the boiler by Chief Inspector McNeil so that any increase in the diameter as the pressure was raised could be noted, with results as follows: With 265 lbs. the middle longitudinal seam was leaking badly; at 290 lbs. there was some leakage around top row of tubes in front head; at 295 lbs. tubes in back head of boiler were leaking a very little in the top row and around the fusible plug; at 305 lbs. leaks showed at front top row of tubes, all longitudinal seams and around the front head, where same was riveted to shell, but the longitudinal seam of the middle plate seemed to be the weakest place, for it was letting a number of small streams of water out of it that were going about twenty feet.

At this point it was thought that by letting the pressure off and calking the joints, a much higher pressure could be gotten on the boiler. Accordingly, Mr. Scannell sent two men from the shop to do the calking. After about one-half hour's work by the calkers, it was thought best to give her a try, and the engineer was given orders to get everything in readiness to give the boiler all the pump could do. The fireman having the steam up to 110 lbs., the pump was started and speeded up quickly, so as to get as much pressure as possible, with the following results:

The pressure was pumped to 310 lbs., when all the seams that had been calked began to let out the water. The pump was given full throttle and the pressure increased to 325 lbs., and the water from the middle longitudinal seam shot away about thirty feet.

After a few minutes, being unable to raise the pressure any higher, the pump was stopped and it was decided that nothing further could be done until the leaks could be stopped, and Mr. Scannell, of the boiler works, could have the seams riveted up as well as possible and larger steam pipe run from the boiler to the steam pump. This pipe was one inch in diameter, full size for the pump, but the pipe being about 100 feet long, and having several elbows, it should have been larger pipe.

After the water had been let out of the boiler it was found that some of the rivets in the middle longitudinal seam had been sheared, and some broken, and the head-to-head braces

loosened a little. The heads showed no sign of bulging, under the highest pressure; the tube ends in the rear head were beaded, while the tube ends in the front head were expanded without beading. The back head being exposed to hotter gases than the front head, it would seem that the back ends of tubes should have been leaking before the front ends, but such was not the case. In laying a straight-edge across the boiler on the lap, it showed to be flat for about six inches.

Saturday afternoon of May 18th about 250 of the engineers and interested friends assembled at the boiler works to witness the final test on the boiler; some of them coming from Haverhill, Mass.

The pump had been piped up with 1½" pipe from the boiler to the steam pump, which gave a good supply of steam to it. The middle longitudinal seam had been re-riveted with new rivets and all seams calked. A tape was put around the middle plate in the same place as at the previous test by Chief Inspector McNeil, and the pump started, with the following results:

At atmospheric pressure the circumference of the middle plate was 17' 4⅜"; at 375 lbs. it had increased to 17' 4 15-16", or an increase of 9-16"; sheared the rivets on one end of the man-hole ring, cracked the plate on each side of the man-hole lengthwise of the boiler, in to the rivet hole, and the cracks were opened up about 1-16". As the pressure could not be raised any higher, with the pump going at full speed, it was decided to stop the pump, let the water out of the boiler and see what damage had been done; after which the man and hand-hole plates were removed and an internal examination made, when it was found that four of the head-to-head braces had been broken, and the other two badly strained. No sign of any cracks in the longitudinal seams were discovered.

The engineers present considered their time well spent in watching the test on this boiler, and the thanks of Lowell No. 17, N. A. S. E., were extended to Mr. Frank P. Cheney for so kindly allowing them to use the boiler for the test, for it is not often that such a chance occurs.

———o———

Hardening and Tempering Steel Tools.

There is scarcely an operation in mechanics which is performed with greater hazard than that of hardening and tempering tools; for if the operation be unskilfully performed, the whole labor of forging and finishing the tool, together with the value of the steel employed, is in an instant wholly destroyed and lost, and nothing avails but to perform again the labor and produce another tool.

The chief dangers to which steel is liable in the process of hardening are warping and cracking. The first may be caused by an unequal density in forging, one part of the steel being more compressed than another by the hammer blows, and unequal contraction results when the hardening takes place, which causes the tool to warp or twist. Another cause of warping is when the thick and thin portions of the tool are so proportionel that in the shrinkage the thinner portion is forced to one side, or pulled away from its proper place, and this may occur to such an extent as to cause the tool to crack in a greater or less degree. Two high a heat or too great coldness of the bath in which the tools are hardened may produce these results.

As a remedy for warping from unequal forging, care must be exercised by the person who does this part of the work, or steel may be used which has been formed by rolling, or by means of the drop and die. An illustration that rolled or drawn steel seldom warps is the twist drill, as made from steel wire. The density of the metal being homogeneous in all parts it seldom warps or springs in hardening. Where a tool is made with thick and thin portions the best remedy is skill and judgment. The thick part must be chilled or come in contact with the water first, and by its first contracting it cannot bind upon the thin part, so as to cause it to give away. It is difficult to give precise directions for such operations, and the best suggestion is that the person entrusted with such tools to harden should be possessed of judgment and experience in these operations and have a knowledge of the nature of the material which he is using. Even in placing tools which have unequal proportions in the fire, a springing or warping may be produced by one part expanding to a greater extent than another, and the same amount of care must be used in heating tools as in hardening them.

With the successful hardening of tools the greatest danger of destruction is past and all that now remains is to reduce this hardness to the proper degree, or as it is technically termed, "draw the temper." Between the extreme conditions of hardened and soft steel there are many intermediate grades, the index of which is oxydation or "coloring of the brightened surface when heat is applied.

The brightening of the surface is done in many ways. A piece of sandstone or grind-stone, or even a piece of brick, is sometimes used. The "buff-stick," which consists of a piece of wood shaped like a file and covered with leather, and the surface coated with glue and emery, is another means often used; but the best of all is the polish wheel.

The tints or colors are produced upon the polished surface upon the application of heat, and the respective approximate temperatures are as follows:

1. 430° Fah.—Very pale straw-yellow.
2. 450° " —A darker shade of yellow.
3. 470° " —Darker straw color.
4. 490° " —Still darker straw color.
5. 500° " —Brown yellow.
6. 520° " —Yellow tinged with purple.
7. 530° " —Light purple.
8. 550° " —Dark purple.
9. 570° " —Dark blue.
10. 590° " —Pale blue.
11. 610° " —Still paler blue.
12. 630° " —Pale blue with tinges of green.

The tempering colors differ slightly with different qualities of steel, some kinds requiring a higher degree of temper or color than others to obtain the same degree of hardness; but a knowledge of this can only be obtained by actual experiment. In the table given Nos. 1 and 2 are used for tools to cut metals; 3 and 4 are for the same purpose where more elasticity is required; 5, 6 and 7 are used for wood cutting tools; 8 and 9 for springs, and 10, 11 and 12 are too soft for any of the above purposes. Many mechanics employ colors or tempers a degree or two lower than these mentioned, and use a sort of general color for certain kinds of tools, making an "average" as to color and quality of steel; but with the mechanic who is particular about the temper of his tools or where a very particular temper is required, the quality of steel must be

taken into consideration and the hardening and tempering done by some one experienced in such operations.

Production of Coal in 1906.

According to statistics compiled for the United States Geological Survey by Edward W. Parker, coal-mining expert in charge, the total production of coal in the United States in 1906 was 414,039,581 short tons of 2,000 pounds, valued at $512,610,744. These figures, compared with those of the preceding year, when the output amounted to 392,919,341 short tons, valued at $476,756,963, show an increase of 21,120,240 short tons, or 5.4 per cent., in quantity, and of $35,853,781, or 7.5 per cent., in value.

Of the total production in 1906, Pennsylvania contributed 200,546,084 short tons, or 48.4 per cent., in quantity, and $262,182,935, or 51.1 per cent., in value, the larger percentage in the value being due, of course, to the higher value of anthracite, which is produced almost exclusively in that State.

The anthracite production of Pennsylvania in 1906 was 63, 645,010 long tons (or 71,282,411 short tons), valued at $131,917,694, while the bituminous production was 129,263,673 short tons, valued at $130,265,241. The anthracite production of Pennsylvania in 1906 was 5,694,142 long tons (or 6,377,439 short tons) less than that of 1905, with a decrease in value of $9,961,306, while the bituminous production showed an increase of 10,850,036 short tons in quantity and of $16,874,734 in value.

One of the interesting facts presented in the statistics of coal production last year is that West Virginia has supplanted Illinois as the second coal-producing State, West Virginia showing a total output of 43,276,485 short tons, while the production of Illinois was 41,497,435 short tons. This was due principally to the almost complete suspension of mining in Illinois (as in other States where labor union forces were strong) during all of April and a part of May, when the miners and operators were in conflict over the wage scale, whereas the majority of the operations in West Virginia were more actively worked, as a result of the suspension of work in the other districts.

Notwithstanding, however, the loss of from six to eight weeks in the States where mining operations were suspended, there was a general increase in production east of the Mississippi River, the only exceptions noted being in Michigan, Georgia and North Carolina. In Illinois, where the question of the wage scale is most sharply contested, the production increased from a total of 38,434,363 short tons in 1905 to 41,497,435 short tons in 1906. Indiana's production of coal increased from 11,895,252 short tons in 1905 to 12,084,281 short tons, the following year. Ohio's production increased from 25,552,950 short tons in 1905 to 27, 729, 843 short tons in 1906, while the bituminous production of Pennsylvania increased from 118,413,637 short tons in 1905 to 129,263,673 short tons in 1906.

In West Virginia, where there was no suspension of mining, the output of coal increased from 37,791,580 short tons in 1905 to 43,276,485 short tons in 1906.

Among the other coal-producing States in which there was an increased production in 1906 were Alabama, Colorado, Iowa, Kentucky, Maryland, Montana, New Mexico, Tennessee, Virginia, Washington and Wyoming. In addition to the three States previously named in which decreases occurred, the following showed losses in tonnage: Arkansas, Indian Territory, Kansas, Michigan, Missouri, Texas, California, Oregon and Alaska. In California, Oregon, Arkansas, Indian Territory and Texas the decreases were due principally to the use of fuel oil. In Kansas, Michigan and Missouri the decreases were due, in the main, to the fact that in these States the industry did not recover from the idleness previously referred to.

Production of Coal in 1906, by States.

State.	Productions.	Value.
Alabama	13,107,663	$17,467,886
Arkansas	1,864,518	2,999,774
California and Alaska	30,831	78,684
Colorado	10,114,074	12,738,509
Georgia and North Carolina	363,463	407,247
Idaho and Nevada	6,165	24,238
Illinois	41,497,435	44,742,440
Indiana	12,084,281	13,105,168
Indian Territory	2,859,450	5,481,053
Iowa	7,321,639	11,688,598
Kansas	6,010,858	8,935,195
Kentucky	9,673,536	9,794,823
Maryland	5,434,528	6,473,829
Michigan	1,336,338	2,402,529
Missouri	3,755,778	6,163,449
Montana	1,787,934	3,186,620
New Mexico	1,963,558	2,635,571
North Dakota	300,998	437,894
Ohio	27,729,843	30,386,297
Oregon	79,731	212,338
Pennsylvania:		
Anthracite	71,282,411	131,917,694
Bituminous	129,263,673	130,265,241
Tennessee	6,262,686	7,682,121
Texas	1,160,707	2,058,731
Utah	1,773,847	2,411,992
Virginia	4,275,815	4,207,521
Washington	3,276,184	5,908,474
West Virginia	43,276,485	40,777,382
Wyoming	6,138,152	8,019,486
Total	414,039,581	$512,610,744

The Edison Electric Company, of Los Angeles, has successfully started up its large hydro-electric power plant on Kern River, and is now regularly supplying power over its 117-mile transmission to Los Angeles and to its distribution network in that vicinity. Water was first turned on the wheels on May 13th, and on the 19th the power was delivered for the first time in Los Angeles. This plant is one of the largest in the country, having a normal capacity of 20,000 kilowatts. It is unique for its eight miles of tunnels, its gravity conduit, its pressure main tunnel, its water-wheel equipment, and its steel tower transmission line, designed for 75,000 volts. The plant in its entirety cost about $3,500,000.

The electric light plant at Bangor, Pa., recently came near closing down, owing to inability of the firemen to get water into the boilers. Upon investigation it was found that the inlet valve to the boiler was clogged up, the cause of the trouble being two eels, one 24 and the other 15 inches in length.

It has been said that if the whole of the power of Niagara were utilized it would only give three times the horse power that is thrown away by the blast furnaces of the United States alone.

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CONTENTS

Power Factor Correction by Synchronous Motors..... 3
Indicator Springs 7
Development of Hydraulic Turbine Sizes..... 9
Sanitary Hydro-Electric Station 10
New Power Rate for Canadian Towns..... 11
The Supply of Air for Combustion..... 11
Balancing Sets vs. Three Wire Dynamos..... 12
Hydrostatic Test of a Horizontal Return Tubular Boiler 17
Hardening and Tempering Steel Tools..... 18
Production of Coal in 1906..... 19
Editorials 20-21
Letters from Engineers:
Remedy for A. C.'s Governor Trouble..... 22
Suggested Change in T. S.'s Pipe Arrangement Will Be All Rright 22
T. S.'s Tank Suggestion Correct..... 23
No Extra Steam Needed for T. S.'s Arrangement.... 23
Prepare for Emergencies. Lesson Taught by Valve Trouble 23
Pointer from Catalogue Save Trouble..... 23
Care and Management of Dynamos..... 24
Suggestion for C. E. N.'s Generator Trouble..... 25
Experiences of a Gas Engine Trouble Man..... 25
Annunciator for Engine Stops..... 26
Rule for Safe Working Load of Wire Rope..... 26
Questions and Answers 27-28
Atlantic City Convention of the A. O. S. E..... 29
Thirtieth Convention of the National Electric Light Association 31
New Power Plant Equipment.....32-33
Trade Notes 34-36

The New Incandescent Lamps

During the past twenty months the electric lighting industry has been stirred from centre to circumference by the many new lamps which have from time to time been put on the market. First, it was the osmium lamp that demanded attention; then the tantalum lamp; then the helion lamp; then the titanium lamp; then the zirconium lamp; again the metallizer carbon-filament lamp, and now the tungsten lamp. In each case the claim made for the new lamp was an increased candle-power with a decreased current consumption over the old carbon 3.5 watt lamp, until the newer helion and tungsten lamps now claim a consumption of only one watt per candle.

The tantalum lamp, which is now ceasing to be a novelty, owing to its wide use, is restricted in its application to principally direct current circuits, and is made only in the 22-candle power, 44-watt size, and is said to have a life of about 700 hours. Already large electric companies are offering free lamp renewals with this type of lamp, and it is being accepted with much favor for many illuminating purposes.

Many of the other lamps, except the metallized filament and the tungsten lamps, may be looked upon at the present time as being not yet out of the experimental stage. The so-called "helion lamp," which is composed largely of silicon, reduced and deposited on specially-made carbon filament, gives a very white light, and its consumption is only one watt per candle power. The life of these lamps is said to vary from 500 to 1,200 hours. The titanium lamp, which is in its laboratory infancy, is said to have very ductile filaments, so that they become very efficient in transmitting the electric power into light. The zirconium lamp also belongs to the one-watt per candle class, and a life of from 500 to 1,000 hours is claimed for it.

The metallized filament lamp, which was one of the first lamps to depose the old carbon filament lamp from its supposed strongly-entrenched but very uneconomical position, takes about 2.5 watts per candle and is being used widely in many cities. They give out a white light of high brilliancy, and are adapted for either alternating or direct currents. The ability of this lamp to protect itself against changes in voltage makes it well adapted on circuits where elevator or power motors cause the voltage to fluctuate because it does not perceptibly change its candle power, owing to the fact that its metallic filament increases in resistance with an increase in voltage and decreases in resistance with a decrease in voltage, just contrary to what happens in the ordinary carbon lamp.

Of all the new lamps being introduced, however, the tungsten lamps seem to have the widest sphere of usefulness. Whether this is because it has been pushed to a greater degree of refinement, or whether it is due to its inherent properties, cannot be said, but it is now available for both parallel and street series operation. The tungsten filaments have a high conductivity and a large positive temperature co-efficient, and are said to possess long life. It gives out a pleasing white light and it behaves like the other metallic filament lamps. When used as a street series lamp it operates at an efficiency of 1 1-3 watts per candle, and on account of its brilliancy and the horizontal direction in which it throws its light, it is particularly adaptable for that class of illumination.

It might be supposed, at first thought, that the central station manager would welcome these new illuminants with open arms, but such is not the case, because for a given illumination the

income of the station would be cut in third if these new lamps are used. Consequently, at the present time, all these lamps are made in sizes much larger than the standard 16 candle power lamp, so that if the consumer is willing to pay the high prices for the new lamps, he will get a greater illumination for his money without the central station being the loser.

When, however, the new lamps prove that they pay for themselves in efficiency, combined with long life, the isolated plants will be in a position to provide the same illumination with only one-third the current passing through the ammeter, and the lamp manufacturers will be compelled, by the very nature of the demand, to make these lamps in sizes at least as low as 16 candle power.

It seems that we are just beginning to know what real electric illumination is, and if the new lamps hold out the promise which they now give, the electric lighting industry will be given a fresh impetus and other artificial illuminants will have to hustle in order to hold their present position in the illuminating world.

—o—

Selecting Apparatus

At a recent meeting of one of the societies of operating engineers a discussion of the relative merits of the water-tube and return tubular boiler took place in which all the various good points of a boiler were claimed for both types. For the return tubular boiler it was claimed that as it holds considerable quantity of water, the reserved heat which is stored in the heated water is capable of giving up this heat when excessive demands come upon the boiler, with but a resultant slow fall of pressure as heat is withdrawn; that is, the storage capacity for heat in the mass of water keeps the pressure uniform under variations in demand for steam and in supply of heat. It was also claimed for the return tubular boiler that it is particularly efficient with short-flame fuels. The objections to the return tubular boiler were that the large body of water which it contains makes it slow in getting steam, and that it requires an elaborate boiler setting and is dangerous at high pressures.

For the water tube boiler it was claimed that on account of the complex path which the gases have to take, the heating surfaces are more efficient; the water tube boiler is lighter in weight for a given capacity; it can be put in places where access is difficult such as in large cities, where ground is valuable; it can be driven considerably over its rated capacity and it is a very safe boiler at all pressures. Against the water-tube boiler were entered the objections that it is very much harder to clean, owing to multiple joints at each end of the tubes, which must be made tight after each cleaning; should a tube fail for any reason, it puts the whole boiler out of commission, whereas in a return tubular boiler, if a boiler tube fails, it can easily be plugged; it is very much more costly and probably not much more efficient than a return tubular boiler; its life may not be so long, and so on.

When the many-sided views, which engineers have about the various devices which are being used in engineering, are considered, it is really a fortunate thing for all concerned that no fixed rule applies in the selection of apparatus. It is the proper discrimination of one's knowledge, together with the conditions of service, that cause certain kinds of apparatus to be selected for certain conditions. If all questions in engineering could be solved by looking up a certain page in a certain book, then engineering would not occupy such a high plane as it does to-day. But after having selected a piece of apparatus of good design, it should be operated in a careful manner, as bad design and careless operation with any apparatus plays havoc with economy.

Too often when making comparisons the best of one type and the worst of another are compared, whereas the best between any two classes may have little difference, and it must also be considered that different conditions under which the apparatus is run may lead to widely different results. Even the same boiler, with different fuel or different firing, may give evaporative results varying by 30 per cent.

Economy very often depends more upon the proper design and proper care of a piece of apparatus than upon the type of apparatus itself. The proper care and attention is directly within the duties of the engineer, but to determine whether it is of proper design is a question which is often very much harder to ferret out.

—o—

A peculiar feature of a recent convention of electric light men was the fact that about 1,500 members and guests had the badge of the association $C = E \div R$ pinned on them, whereas in their discussions the formula $I = E \div R$ was used. Just why the symbol for current was ever changed from C to I has never been satisfactorily explained, except that the committee who had charge of the standardization of electrical unit some years ago thought it would be better to make the change so as to conform with European practice. Seems as if some committee might come along and change the initials of your name some day to conform with the new 40-letter alphabet which nobody has discovered yet.

—o—

Approximately, the number of gallons delivered by a pump per minute with a plunger speed of 100 feet will be

$$G = 4\,D^2,$$

in which G = number of gallons delivered per minute and D = diameter of plunger in inches. The loss by leakage and slip varies from 10 to 40 per cent., depending upon condition of the packing and pump cylinder.

—o—

The power of any gas engine of given cylinder dimensions and given revolutions per minute is dependent upon the effective pressure brought to bear against the piston head during every working stroke. The amount of compression, the volume of clearance space and the nature of the fit between piston and cylinder have much to do with the average pressure generated and maintained in the cylinder during the working stroke of the engine, so that there is often a difference of from 15 to 20 per cent. in the power generated by engines of the same size and design.

—o—

Aside from the well-known advantages of the induction type of motor from the point of view of mechanical efficiency, one very important feature is its absolute safety and freedom from fire hazard in places where any other type of power machinery would be more or less dangerous. This quality has recommended the adoption of induction motors for use in paint mills and powder mills where the consideration of safety is paramount.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Remedy for A. C.'s Governor Trouble.

EDITOR THE PRACTICAL ENGINEER:

I would like to give my explanation for the racing of the Corliss engine as cited by A. C. on page 29 of the April issue. I had a little experience along this same line. The engine would govern all right when the load was on, but when running light the governor would not hold the engine steady. An examination of the valve gearing and cut-off arrangement showed that the links were set so that when the governor was at its highest point one valve was cutting off too late, and consequently the speed would vary, first fast and then slow. By adjusting the rods running to the cut-off cams, so that the governor would operate the cut-off at a lower speed, and consequently at a lower plane of travel of the governor balls, the trouble was removed.

From the data given by A. C. it appears that the governor is sticking from some cause or other. It is possible that the gag pot is filled with gummed oil, or that some part of it is out of adjustment. Such defects will cause the engine to operate badly. If the engine refuses to operate after getting into its racing troubles, it seems that the best thing to do would be to go over the entire governing arrangement and make sure that it is perfectly adjusted and in order. It would not be a bad idea, however, to give the governor a good oiling with kerosene oil so that all gummed oil, if there is any, would be softened and washed out. Some governors are so constructed that it is a difficult matter to properly lubricate the inner parts thoroughly. The oil that does find its way in frequently becomes gummed and then trouble comes. If it is decided that the governor attachments require adjusting it should be gone about in a thorough manner and made a complete job. The following is about what should be done in such a case.

First unhook the engine and block up the governor 3/8-inch and place the wrist plate at very near its extreme throw toward the crank end, which will open the head-end steam valve wide open. Then adjust the cam rod connecting to the cam collar on the head end of the cylinder to such a length as will cause the head-end valve to unhook when the wrist plate has been moved to its extreme throw, which will be indicated by the marks on the hub of the wrist plate and stud. After securing the cam rod at the head end, block the governor up another 1/4 inch, which will cause the governor to be raised 5/8 inch. Then make the crank-end cam rod of a length so as to cause the steam valve on the crank end of the cylinder to be released when the wrist plate is moved to its extreme travel toward the head end of the cylinder. The governor is raised when adjusting the crank-end valve because of the angularity of the connecting rod. It is necessary to do this if the cut-off is to be uniform in both ends of the cylinder.

Having adjusted the cam rods, the governor should be blocked up to its full position, and the valves tested to see that they do not hook on. This adjustment will prevent the engine from running away even if the main belt should break, as it sometimes does.

If the collar which is found on some types of Corliss governors prevents the governor from reaching a position when blocked up to prevent the steam valves from hooking on, it should be adjusted higher, care being taken, however, to keep the governor from being pushed up enough to raise the guide blocks out of their slots.

On the cam collars, on which are placed the knock-off cams, are adjustable collars known as knock-off cams. When the governor is resting on the safety pin or collar, these safety-stop cams should be so adjusted that they will just clear the hooks and so prevent the steam valves from hooking on, should the governor drop to its lowest position when the engine is running.

After adjusting the cam rods, cut-off and safety cams, and the engine gotten into operation, an indicator should be used to determine accurately the equality of the cut-off on both ends. If it is found that the head end has a longer cut-off, the cam rod on the opposite, or crank end, should be shortened, with the crab-claw type of gear, and lengthened if the engine is equipped with the oval arm gear which operates the valve outward. In both types of valve gear the head-end should remain as previously adjusted. After making the last adjustment it is likely that the safety cams will require readjusting, as this cam may come into operation too early when the engine is slowing down, and so prevent the crank-end valve from hooking on when the governor rests on the safety collar. If this were allowed to remain there would be trouble in getting the engine started, even with a light load, as it would stop on the opposite dead centre. E. P.

Cleveland, Ohio.

Suggested Change in T. S.'s Pipe Arrangement Will be all Right.

EDITOR THE PRACTICAL ENGINEER:

On page 28 of the June issue a writer, T. S., would like to have the opinions of some of the readers in reference to the suction pipe to jet condenser and the proposed changes. I would like to say that in my opinion, so far as getting the same amount of vacuum is concerned, after making the change, he is all right, but I do not think he will have to increase the diameter of the suction pipe. My reason for this is that the supply to any condensing pump is usually throttled in order to get a certain amount of vacuum, and as the suction pipe is large enough at present, increasing its diameter would not have much effect on this problem.

In figuring what pressure a pump is working against, it is the rule to figure both sides of the pump; that is, the head of water the pump must discharge against and the inches of vacuum on the suction side. The figures used in the calculation are .434 pounds per square inch for each foot in height on the discharge side of the pump, and 1.133 feet for each inch of vacuum on the suction side of the pump.

I would like to suggest to T. S. that he tap into the suction pipe below the injection valve, or close to the condenser, and put on a vacuum gauge and take a reading; then if he makes a change, he will have a chance to prove for himself whether the change affects the gauge reading.

Fall River, Mass. M. H. H.

T. S.'s Tank Suggestion Correct.

EDITOR THE PRACTICAL ENGINEER:

In looking over your valuable paper I notice in the June number T. S.'s suggestion to his chief, which is a correct one. Mr. Chief can use the tank for some other purpose, and at the same time he will have two 45-degree ells left over. All that is needed is an elbow, when the pipe can be run straight to the wheel pit and the strainer adjusted on the end of the pipe. He can get plenty of water for condensing purposes and, in my opinion, the present pipe is sufficiently large, and the steam consumption will remain the same as at present. I would advise T. S., however, not to make too many suggestions to the chief unless he has another job in view.

Fall River, Mass. A. J. C.

No Extra Steam Needed for T. S.'s Suction Pipe Arrangement.

EDITOR THE PRACTICAL ENGINEER:

In the question and answer column of your June issue, T. S. asks why the suction pipe could not be changed as he has shown in the diagram. I think it could be changed and an improvement made over the old way. Under the existing conditions it seems to me that it must be necessary to throttle the injection, and even with the twelve-foot lift it would be necessary to do so unless the load is very heavy or the injection water quite warm. If the injection pipe is of the size required by the condenser specifications, it is large enough, and with the twelve-foot lift it will take care of any load within the capacity of the condenser.

It is my opinion that no extra steam consumption will be needed, no matter what the lift may be, provided, of course, that it isn't more than the pump can lift.

N. Abington, Mass. E. T. R.

Prepare for Emergencies. Lesson Taught by Valve Trouble.

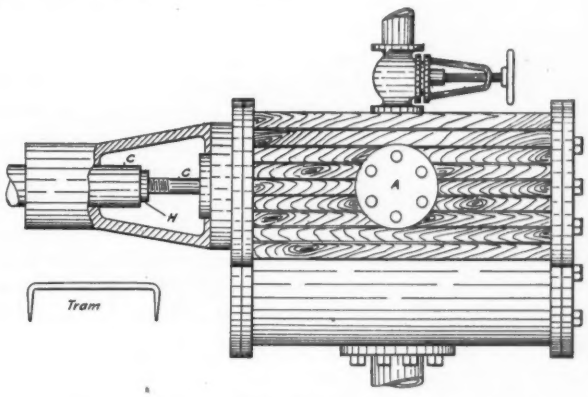
EDITOR THE PRACTICAL ENGINEER:

An instance witnessed some time ago by the writer demonstrated the truth of the old familiar adage, "In time of peace prepare for war."

A 300 H. P. cross-compound engine running 250 R. P. M., which had always ran quietly and given no trouble, suddenly went wrong. As a shut-down for the purpose of ascertaining the cause of the trouble was entirely out of the question, we were obliged to listen to the poundings and belabored efforts of the engine all day, and plan for the best way of remedying the trouble when it was time to shut down.

After a careful inspection, during which we found the wrist and crank boxes in good order, we decided to apply the indicator. The cards we took showed that the valve had in some manner become shifted so that all the work was done on one end.

The engine was equipped with a centre-admission piston valve which moved in a jacketed valve chamber, and by removing the cover A, the movement of the valve over the ports could be observed. After placing the crank on each dead centre and equalizing the lead by screwing the valve-rod in the round guide-block we started the engine. The indicator then produced a card which was fairly good, considering the high speed and rapidly fluctuating load.



Tramming Valve Rods may Prevent Shut Down

After this the engine ran quietly once more, and we were ready for service. Before starting a 3-inch tram was made as shown in sketch and punch marks were made on the valve rod and guide-block, as shown at C-C. What deceived us was the fact of the lock-nut at H was tight, although the condition of the valve rod thread seemed to indicate that the valve rod had backed out of the guide-block.

This little incident was not without its beneficial results, for it taught us that when things were running smoothly to prepare for an emergency, by having everything marked so that it may be readily adjusted when misplaced.

Columbus, Ohio. M. B.

Pointer from Catalogue Saved Trouble.

EDITOR THE PRACTICAL ENGINEER:

The controversy as to the value of informtaion obtained from catalogues and advertisements, reminds me of an incident, or rather an object lesson on this subject, which may be of interest to some of your readers.

The writer was only an apprentice at that time, but very much interested in engineering, and read and studied everything pertaining to that subject in books, ads, and catalogues. The plant was located in the basement of one of the largest retail stores in the country. One day it was decided to install a pneumatic tube system for handling the cash. There were many bids for engines to run the blower, and consequently catalogues were plentiful. An engine of a certain make was decided upon and the catalogue descriptive of this engine received my special attention for several days. I noticed that safety cups were placed under the cylinders with double seated valves, to shut off the passage from cylinder to drip connection, or to safety cup as occasion required.

The engine was installed and the oilers received special instructions to keep their eyes open while around the engine, as a shut-down would result in the tying up of the cash of a thousand customers. Everything went smoothly for a while,

until one day the engine received a dose of water which blew out the safety cups. Imagine the noise from the steam at 110 pounds pressure blowing out in the room from an inch opening, and not a steady flow, but interrupted about 200 times per minute. I was employed in another part of the building, but, like everyone else, made for the engine room. The chief happened to be out, but standing around the engine were his first assistant, the chief machinist, a couple of oilers and some others, who, like myself, had no business there. The general manager, who had heard the noise from the floor above, came down and was discussing with the assistant engineer the advisability of shutting down long enough to cap the opening. Not willing to incur the enmity of the chief machinist, I went quietly over to the oiler, who had immediate charge of the engine, and told him if he opened the drip valve wide he could stop the noise and put on a new cup. He did so and the trouble was over. The chief machinist, however, had a peculiar way of looking at me for quite awhile afterwards.

The writer has picked up many good pointers and ideas since that day by studying catalogues, and never lays a new catalogue aside before first looking through it carefully.

Chicago, Ill. R. C.

Care and Management of Dynamos.

EDITOR THE PRACTICAL ENGINEER:

The care and management of dynamos, especially direct current, should be of interest to every stationary engineer, even though at the present time he may not have any under his charge. In many places it is only a question of time when electrical machinery will be installed, and then, if the engineer does not know how to care for it, he may have to look for work elsewhere. To illustrate the point: A short time ago an engineer, who is well known to the writer, secured a position where dynamos and motor generators were being put in for lighting purposes. The man with whom he worked styled himself assistant chief and had held the position for something like twelve years. He was one of those fellows who thought it unnecessary to read engineering papers, much less to bother studying anything in the electrical line. In due time the new machinery was ready for operation, and this twelve-year assistant chief was so helplessly ignorant that his position was given to the new man who had been there only a short time, and the other fellow was given the job of keeping the engine room, engines, etc., clean.

The writer will herewith give some instructions regarding the care and management of dynamos which, he trusts, will be of interest to someone: Dynamos should be kept thoroughly clean at all times. Give each machine a thorough wiping after a run, the same as you would the engine. Waste can be used to wipe the bearings, frame, etc., but use cheese cloth to wipe the commutator and brushes. There are places which cannot be reached by wiping. If there is no compressed air to be had, procure a hand bellows and blow the dust and dirt from the fields and armature at least once each week; oftener if the dynamo is located in a dirty place. Grease and carbon dust can be removed from commutator with a piece of cheese cloth moistened in kerosene. It is good practice to clean brushes with the same.

Carbon brushes are used in some types of machine, and they usually bear endwise on the commutator. New brushes should always be fitted to the commutator, one brush at a time. Put the brush in the holder, and between it and the commutator insert a piece of sand-paper, sand next to brush, pull paper back and forth until the end of brush conforms to the curve of commutator. Each brush should be treated the same. I find it is good practice, when it becomes necessary to remove the brushes for any cause, to replace them as they were taken out.

Should the brushes not wear down even, due to soft spots, they should be treated as above, so the full area will always be in contact with the commutator. The tension on the springs which holds the brushes on the commutator will have to be regulated according to the make of brush; some do not require as much as others.

The brushes should be kept clean on the outside and the holders on the inside, so the former is free to move in the latter, for should they stick in the holder the tension of the spring may not be sufficient to keep them in contact with the commutator. If any of the readers of this letter have occasion to select a dynamo see that the pressure from the spring is on the centre of the brush and not on the edge, the former being a much better arrangement than the latter.

Keep the commutator as smooth and clean as possible. Not necessarily bright, for, as a rule, they give best results when a brownish color. Should the commutator get rough, when not too bad, it can be smoothed with fine sand-paper. Take a piece of hard wood one inch thick, width and length to be governed by size of commutator, hollow out one side so it fits commutator nicely and fasten sand-paper to this block. If fastened with nails, be sure they will not come in contact with commutator. Remove brushes from holders, revolve commutator slowly, press block to which paper has been attached, firmly on commutator, and move the block back and forth endwise across commutator so the smoothing will be done even. Should the commutator become very rough and uneven, due to various causes, it will be necessary to turn same down, which can be done in two or three ways.

We are now ready to start our dynamo. Before doing so, however, first see that brushes are in their respective holders and bearing properly on the commutator. See that all electrical connections in and about the dynamo are intact. See that no tools of any kind have been left around the dynamo where they are liable to be drawn into the moving parts.

See that there is plenty of oil in reservoir under the bearings. If there is no current on the switchboard, all switches should be open. Also have rheostat at point where the greatest resistance is in circuit. After machine is up to speed, see that the oil rings are turning freely on shaft. Close field switch and cut out enough resistance from rheostat to bring voltage up to the right point. Close circuit breaker, then the pole switches. The positive and negative should be closed at the same time. The machine is now ready for the load and the feeder switches should be closed one at a time, so if there are many lights turned on the load will not be thrown on all at once. We should now see that the brushes are at the point where the least sparking occurs, or better none at all. It may be necessary to shift them in order to stop the sparking. Shift them in the direction of rotation as the load comes on, opposite as the load goes off, if found necessary to shift them at all to prevent sparking.

If one dynamo is running and another is needed, and they are to be run in multiple, proceed as before up to the point where the idle machine is to be cut in on the line. At this point make sure the equalizing switch is closed and that the voltage of the two machines are alike. The machine may then be put in service the same as before. After they are running together it will probably be necessary to equalize the load a little by adjusting the rheostat of one machine, or both.

Should circuit-breaker drop out, due to a momentary overload or some other cause, open pole switches before putting it in. It is also good policy to open several of the feeder switches before putting machine back on work again. This is done so as not to throw the whole load on at once.

The machine or machines should be inspected frequently during a run and not allowed to become overheated either in the bearings or the electrical part. The fields can be tested with the hand, and one can judge very closely as to the temperature of the armature by the feeling of the air which comes from it.

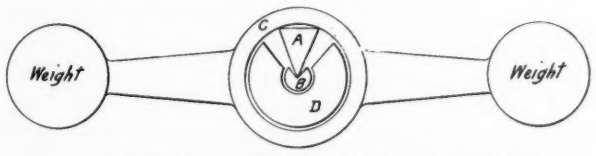
A. K. BELL.

Poughkeepsie, N. Y.

Suggestion for C. E. N.'s Generator Trouble.

EDITOR THE PRACTICAL ENGINEER:

I would like to offer a suggestion in reference to the question asked by C. E. N., on page 28 of the June issue of THE PRACTICAL ENGINEER.



Governor Arm which Caused Generator Trouble

I had the same trouble with a 300 K. W., 545 amp., 550-volt machine, direct connected to an automatic engine. Things kept going from bad to worse, until we were forced to carry 600 volts with no load, in order to have 550 volts with 400 amps., with series shunt entirely out. The trouble was with the governor on the engine, which is of the fly-wheel type. The wedge A and the roller B were so badly broken that they let hub C down on pin D, which caused the governor to be slow in acting. We had a new wedge and a new roller made and now everything works O. K.

Of course, this may not be within a mile of what is wrong with C. E. N.'s generator, but is simply offered as a suggestion.

J. F. H.

Ripley, N. Y.

Experiences of a Gas Engine Trouble Man.

EDITOR THE PRACTICAL ENGINEER:

As my business is to find the troubles in gas and gasoline engines, and to remedy same, I will enumerate a few of my experiences, as they may prove interesting.

One evening I had a call from a man who lived about 150 miles away. He was very much excited and wanted me to come at once, but as no train left until next morning, I did not arrive until the next day at noon. When I arrived I found two men, one scared and the other mad. The former had sold the latter a small engine of fairly good make, and it was intended to run a small vertical centrifugal pump. The man who bought the engine had threatened to throw the engine out because the pump would not throw any water. I tried the engine and found it O. K., and I told him to put on the belt and we would try the pump. He put on the belt, and I asked him if he had not put it on with the wrong twist. He informed me that he had run that pump for three years with another engine and that he knew what he was doing. I said nothing, but slipped the belt, gave it the other twist, and then started the engine, when there was water flying everywhere.

Another call was as follows: "Come at once; extra pay; mill shut down; men all idle." Upon my arrival all hands gathered to see what kind of a dose the doctor was going to give the brute. Some suggested dynamite and others paregoric. I immediately began at the spark plug, but they all said that was all right, as they had it out a dozen times. I found a very weak spark, however, and pronounced it a case of weak battery, but the man in charge declared that it had recently been renewed and used only one month. I examined the battery and found the second cell completely used up. No doubt the zinc and copper oxide had been in contact, shortening the cell and thus destroying it. Upon cutting this one out, the engine started and run O. K.

Another long-distance call was, "Cannot start engine; come at once." Arriving there in the evening, I found they had been using two sets of dry batteries, six in each set. The old one had worn out and they had put in new ones. They had the new ones wired properly, but had connected one negative pole and one positive pole to the ground wire, and had connected both positive poles to the two switches and bridged across the two negative poles, thus short-circuiting the batteries. They declared the others were connected the same way, but all the positive proof and explaining that it would be impossible to use a battery was of no avail. I made the proper connections and departed.

Upon arriving home late one evening, a message was awaiting me to come to a neighboring station early next morning. Upon investigation I found an engineer who knew it all and who needed no advice. As long as the engine did not fail to start he was all right, and when the batteries wore out he knew all about the Edison cells. He dumped out the caustic solution and filled the jars with sal-ammoniac solution, but failed to get any spark. I renewed the battery properly by getting new copper oxides, zincs and caustic.

Another man was using cheap cylinder oil, and I advised using only the very best, even though it cost twice the price. This same man called on me a few weeks later to find out what was wrong with his engine, and when I examined it, I found the exhaust muffler and piston rings completely gummed up.

Another engineer could not keep his crank pin brasses from peeling and sticking, and I at once told him that at some time the box had been heated very hot and was suddenly cooled with water. He acknowledged that he had turned the hose on it one day when it was almost red-hot. He thus destroyed the temper and his trouble followed.

In many cases the owners of engines think that the trouble man puts in more time than necessary on repair work, and perhaps some do, but what is worth doing should be done well.

Many times I find an engine improperly erected and advise changing different things, such as cooling water arrangements or oiling devices, and sometimes the exhaust and carburetters. But many of them say, "Well, the man that sold me the engine ought to know what is best, as they put in many of them." This is not always true, as I have often erected engines according to instructions, and after giving the engine a fair trial and the buyer had accepted it, I would advise certain changes and, whenever followed, the owners were well pleased.

In sending for the trouble man, treat him with civility, as he will give you much valuable information. If he is slow but careful, don't get nervous, as you will get a good job; but beware of the cyclone man. He will invariably spoil more material and do poorer work, and will cost you more in the end. He has no time to instruct you, and you will find him gruff and unobliging. J. M.

Los Angeles, Cal.

Annunciator for Engine Stops.

EDITOR THE PRACTICAL ENGINEER:

We have four engines, each in a separate room, three of them are of the single condensing type and the fourth is a compound condensing engine. These engines are fitted with the Monarch engine stops and regular bells, in connection with which there are two groups of four bells each, one group being in the machine shop and the other in the superintendent's office. These bells let the superintendent and master-mechanic know when the engines stop during working hours. Formerly when a bell rang in the shop the man nearest to the group would endeavor to see which one had rung; that is, if he got there before the bell had stopped ringing, which was not always possible. When it was uncertain as to which bell had rung, some of the men would go to one engine room and

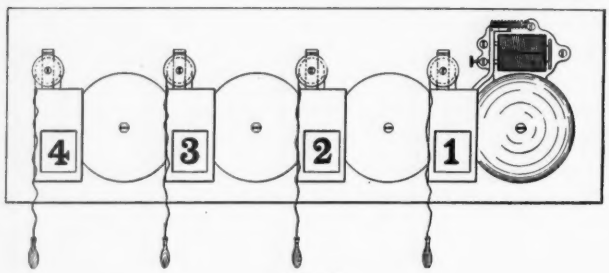


Fig. 1

some to another. This caused a waste of valuable time as when an engine stops during working hours in a large cotton mill, immediate location of the trouble is necessary. I put up with this arrangement for a few months and then looked around for a suitable annunciator to attach to the bells, but could find none of suitable size, and after consulting with the superintendent it was decided I should make one. The following is a description of the one I made, which has proved very satisfactory during the six months it has been in operation:

Fig. 1 shows the bells and annunciators, there being one annunciator for each bell. The figures are 2½ inches high and 2 inches wide, and are painted white on a dark blue background, making them quite distinct. In Fig. 2, which represents a detail of the annunciator mechanism, the piece A is made of cast iron to give it weight, and a steel piece B is fastened to the back. When the figure is up and out of sight the steel piece B rests on the top of the lever C, which is held up under it by a light spring K. The wrought iron piece D

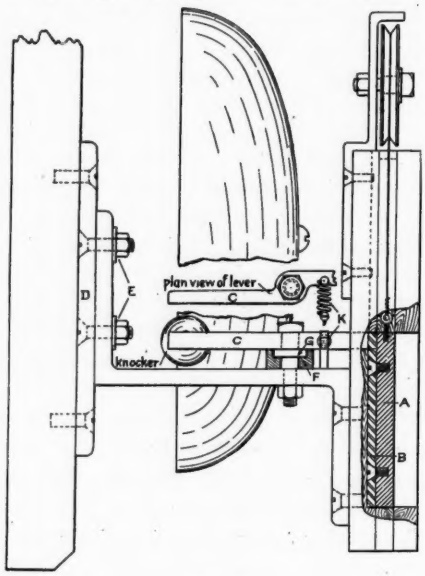


Fig. 2

is fastened to the board as near to the bell as can at first be determined, because after the bell has been rung once or twice the whole device may be adjusted to the required position by means of the slotted holes showing at E. The bearing F for the lever C is counterbored to cause as little friction as possible and is held in place by the shoulder on the stud G, which is squared just enough to allow an easy movement of the lever.

When the bell rings, C is pushed away from B with the first vibration, allowing A to drop, thereby indicating which engine has stopped. Afterward the figure is pulled up out of sight by the cord H. C. H. W.

Natick, R. I.

Rule for Safe Working Load of Wire Rope.

EDITOR THE PRACTICAL ENGINEER:

I have noticed a question in the April number in which A. F. wishes to know the working load of a 2⅛" steel rope. The answer given is about 28 tons, but I would like to give the rule for finding the correct safe working load of any wire rope.

Rule.—The maximum working load in pounds that should be allowed on any wire rope is equal to the square of the circumference of the rope in inches, multiplied by 1,000 for steel, or 600 for iron;

or $W = 1{,}000\ C^2$ for steel rope.

In A. F.'s problem, $C = 2\frac{1}{8} \times 3.1416 = 6.6759$; then $W = 1{,}000 \times (6.6759)^2 = 44.567$ pounds or 22¼ tons, the safe working load.

Seattle, Wash. B. E. T.

Cracks in concrete chimneys are becoming very prevalent. Smoke can be seen issuing from the side of concrete chimneys which are less than one year old.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Concrete for Foundations.

EDITOR THE PRACTICAL ENGINEER:

I am about to put in a foundation for a new engine. Will you kindly tell me a good mixture to use?

Baltimore, Md. E. M. O.

A good, strong concrete for engine foundations can be made of one part of Portland cement, two parts sharp sand and four parts of coarse gravel or crushed rock. The sand and cement should first be mixed together dry, by shoveling into heaps on a smooth platform. When thoroughly mixed, the gravel or crushed rock should be added. Water should then be added with a sprinkler or hose, the whole mixture being "cut" back and forth a number of times. Enough water should be used to give the cement the consistency of a very thick mortar. Concrete should be tamped in place and allowed to set for at least three days before tightening up foundation bolts.

Setting Eccentrics on Greene Engines.

EDITOR THE PRACTICAL ENGINEER:

I am running a 150 horse power improved Greene Corliss Engine, and, as this is my first experience in running one of these engines, I would like to know how to set the eccentrics.

Central Village, Conn. H. A. C.

When setting the eccentrics of this type of engine, loosen both eccentrics from the shaft and see that the valves move equally over the ports. If not, they must be made to do so by adjusting the eccentric rods to the proper length. This can be done by moving the steam eccentric around on the shaft from one dead center to the other, and if the ports are not open an equal amount, and one valve is found to open the port as much too wide as the other fails to open it, the movement can be equalized by adjusting the length of the eccentric rod.

Having the eccentric rods adjusted, the eccentrics are ready to be set. Place the crank on the dead center nearest the cylinder and the full side of the steam eccentric the same. Then move the eccentric in the opposite direction to that in which the engine is to run until the valve at the head end opens the port to the amount of lead, which should not exceed $^1/_{32}$ inch. Fix the eccentric to the shaft at this point. Then turn the engine to the opposite dead center, when the valve on the crank-end should have opened the port an equal amount.

To set the exhaust eccentric, first measure off on the guides from each dead center, a distance of about 3 inches. Turn the crank in the direction it is to run until the crosshead reaches one of these lines on the guide. Then turn the eccentric in the direction it is to run until the exhaust valve just closes the port. Fix the eccentric on the shaft and turn the engine over in the same direction until the crosshead reaches the line at the opposite end of the guide, when the opposite exhaust valve should have just closed the port. If it does not, it can be made to do so by the adjustable link.

Speed and Specific Heat Problems.

EDITOR THE PRACTICAL ENGINEER:

Will you please answer the following questions:

1. How many revolutions per minute must the driving gear, having 18 teeth, make, if the driven gear has 81 teeth and makes 80 revolutions per minute.

2. A fly-ball governor is designed to run at 88 revolutions per minute; the speed of the engine is 200 revolutions per minute, the diameter of the governor pulley is 8 inches, the number of teeth in the bevel gear which it turns is 44, and the number of teeth in the other bevel gear is 75. What must be the diameter of the pulley on the crank shaft which drives the governor belt?

3. A ball of copper at 305 degrees, weighing 18 pounds, and an iron rod at 278 degrees, weighing 13 pounds, are plunged into a bath of water at 56 degrees. If the water weighs 32 pounds, what will be its final temperature?

Washingtonville, Ohio. E. G.

1. 360 revolutions per minute.
2. 6 inches diameter.
3. The final temperature of the water will be 77.4 degrees.

Travel of Crank Pin.

EDITOR THE PRACTICAL ENGINEER:

Kindly answer this argument in your paper: A says that when the wrist pin of an engine is on the centre of its stroke the crank pin is either on the top or bottom quarter. B says it is not, and has figured out that the crank pin hasn't reached the quarter, therefore making the crank pin travel further the last half stroke of the wrist pin. Which is right ?

Dawson, N. M. O. F. S.

B is correct, the explanation for which will be found in the March, 1907, issue under the heading of "Angularity of the Connecting Rod."

Size of Cone Pulleys. Positive and Negative Side of Dynamos.

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions in your next issue:

1. How to find the size of the driving pulleys to drive a cone pulley using the same belt?

2. How to tell the positive from the negative side of a dynamo?

Roxbury, Mass. G. E. D.

1. The same length of belt can be used on cone pulleys if the condition $D + d$ is maintained, where D represents the diameter of the driving pulley and d, the diameter of the driven pulley. If, therefore, a cone pulley has three diameters, say 8, 6 and 4 inches, the cone pulley to match with it will have diameters of 4, 6 and 8 inches. The theory of this subject does not exactly agree with this, but unless the cones have large differences of diameter, giving a large belt angle, the

sum of the diameters may be kept constant for all practical purposes.

2. As all power plants are equipped with recording instruments, such as voltmeters and ammeters, and, as the binding posts of such instruments are marked plus and minus, the instrument can be temporarily connected up, and, if the instrument does not read correctly, it can be made to do so by reversing the connections. When the instrument reads correctly, the wire leading from the plus binding post can be followed to the dynamo which will give the positive side.

Pump Questions from India.

EDITOR THE PRACTICAL ENGINEER:

Will you please let me know, through your next issue of THE PRACTICAL ENGINEER, the following:

1. What rule is used for finding the lifts of the suction and delivery valve of a pumping engine, in which the bore of the suction pipe is 2 feet 4 inches diameter?

2. Between what points of the pump is the lift of the pump calculated, when the suction valve is working below the level of the water all the time, or in a case where it is working above the level of the water?

Calcutta, India. C. R. M.

1. In a given pump, the area of the valve seat, or seats, can easily be found from which the lift of the valve can be obtained. For instance, suppose the outside diameter of the opening through the valve seat be 4 inches, and the inner opening to be 2½ inches; then the net area equals 7.66 square inches, and the net circumference equals 20.41 inches. The lift required will, therefore, be $7.66 \div 20.41 = .375$ of an inch to give the full area. If there are a number of valves, the net area and the net circumference should be found, and the lift worked out in the above manner, the lift depending upon the design of the valve.

2. If the cylinder of the pump is horizontal, the lift of the pump is the vertical distance between the level of the water supply and the center of the cylinder.

Horse Power and Boiler Pressure. Pressure on Pipe.

EDITOR THE PRACTICAL ENGINEER:

Will you please answer these two questions for me?

1. What is the pressure on a 75 horse power boiler?

2. What pressure is exerted at the base of a pipe ¼" internal diameter and 16 feet long, the pipe being filled with water?

Depew, N. Y. C. W. D.

1. The pressure on a boiler does not determine what its horse power is. There are three factors which enter into the consideration of the horse power of a boiler; namely: the number of pounds of water evaporated per hour, the temperature of the feed water and the pressure at which the steam is generated. According to the generally accepted rating, one horse power is equivalent to the transfer of 33,305 thermal units of heat per hour or the evaporation of 34½ pounds of water from a feed water temperature of 212 degrees into steam at the same temperature.

2. This problem can be interpreted in two ways. If the pipe is horizontal, and there is no external head of water on the pipe, then the pressure on the lower element of the pipe is due to a head of ¼" or 0.108 pounds per square inch. If the pipe is vertical, then the pressure on the base of the pipe due to the head of water on it is $16 \times 0.433 = 6.928$ pounds per square inch.

Increased Power Due to a Condenser.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer the following questions through the columns of your paper? What horse power does a condenser add to a cross-compound engine, 18" x 32" x 42", running at 78 revolutions per minute, and what horse power does it take to run the condenser, which is of the bucket type, 16" x 16", belt driven, and running at 75 revolutions per minute, with a vacuum of 24 inches and a water lift of 14 feet?

Rock Falls, Ill. E. A. F.

The increase in power that may be obtained by adding a condenser to a non-condensing engine is generally assumed to be equivalent to a net gain of 12 pounds mean effective pressure per square inch of piston area. That is, if A is the area of the low-pressure piston in square inches, and S is the piston speed in feet per minute, then the horse power increase, due to the vacuum, is represented by the formula $H.P. = 12\,AS \div 33{,}000$.

In the given problem, $A = 804.25$ square inches and $S = 3.5 \times 156 = 546$ feet per minute, so that the horse power gained is equal to $12 \times 804.25 \times 546 \div 33{,}000$, or 159 horse power.

The amount of water handled by the condenser can be obtained from the dimensions of the pump. At each stroke, the pump displaces 1.86 cubic feet, or 116.25 pounds, and since the pump makes 75 strokes per minute, the water displaced equals $116.25 \times 75 = 8718.75$ pounds. The lift being 14 feet, the number of foot pounds being exerted per minute is $8718.75 \times 14 = 122{,}062$ foot pounds, or about four horse power. Assuming an efficiency of about 60 per cent., the amount of power required by the pump would be about 6.5 horse power.

Causes for Breaking Water Glasses.

EDITOR THE PRACTICAL ENGINEER:

I wish to get some information about gauge glasses, as I can't make my water glasses last. Some last a month and sometimes one lets go every day.

St. James, Mich. W. J. G.

In regard to gauge glasses there are a number of points that should be considered. To begin with, the glass should be of good quality, and the glass must not be too large for the size of the gland. Many glasses are broken from these causes alone. Then the gauge cocks should be perfectly true, otherwise the glass will have too little space for expansion on one side. The packing around the glass must be of good quality. In screwing up the glands the glass should be clamped so that it can be moved with the finger and the thumb. If it is caught any tighter than this, there will not be room enough for expansion, and breakage will result. With the glass left easy, there will be a little leakage when steam is put on, but this will take up as soon as the glass and packing expand. One point to be particularly noted is that the glass breaks most frequently at the steam end of the gauge cock because the steam is hotter than the water in the glass and causes more expansion. This should be remembered when screwing up the glands so that the steam end of the glass is left a trifle slacker than the water end, and in every case the steam should be turned on gradually.

ATLANTIC CITY CONVENTION OF THE A.O.S.E.

Down at Atlantic City, the pleasure lovers' paradise, the gem of the Atlantic seaboard, the magnet that draws pleasure-loving humanity from all part of the globe, and never disappoints; down where the lights shine brightest and the merry throngs are ever responsive to any call that is born of gladness.

Where the sunshine only gladdens;
Where the rain falls to bless;
When the breezes, ocean laden,
Greet you with a fond caress.

With apologies to Mark Twain and the Hawaiian Islands. But getting down to brass tacks, that is where the American Order of Steam Engineers held their Twenty-first Annual Convention Monday, Tuesday and Wednesday, June 10th to 13th. The order is now old enough to vote, and if it doesn't turn in with the reformers we suppose it will be "wid de gang." If it goes the latter road charge it up to Billy Le Compte, who drilled a company of recruits all night on the boardwalk to the tune of "Hail Hail," with "Buz" and "Cos," two veterans heading the line of march; but this little stunt was only incidental, for there was something doing all the time. Monday afternoon there was a sail on the briny deep, and some of the delegates wondered why the boat wouldn't keep still.

The Delegates and Supply Men in Attendance at the A.O S.E. Convention held at Atlantic City, N. J., June 10th to 13th.

The star feature of the entertainment was a "Smokeburner" given Tuesday evening in the New Berkeley Cafe. Now, all you scientific engineers who say there is no such thing as a "Smokeburner" would know better if you had been there, for it was the real thing. There was a delightful luncheon of radishes, olives, little neck clams, deviled crabs and chicken salad, with your favorite on the side, and then cigars, all of which was followed by a vaudeville entertainment of a high order, producing mirth enough and to spare. The talent, which was entirely volunteered, included John Armour, John Lloyd Wilson, Frank J. Corbett, Herbert Self, William Murray, Frank A. Knowles and Henry Fratzen.

Many men well known in the engineering field occupied seats near the stage and forgot their cares in the mirth of the hour. Among these were A. J. Dietrich, Supreme Chief Engineer of the A. O. S. E.; A. C. Buzby, General Manager of the Keystone Lubricating Co.; John R. Livezey, A. R. Foley, Captain J. E. Doughty, Hudson Dickerman, Geo. S. Costello, Chas. J. Curran, H. S. Demarest, H. G. Logan, A. W. France and many others, whose modesty, or the lack of room, caused them to find seats farther back in the audience. All together, it was a delightful affair, and proves beyond question that "Smokeburners" are possible.

Wednesday morning the delegates held a real serious business session and elected officers for another year as follows:

Supreme Chief Engineer, A. J. Dietrick; Assistant, J. T. Harris; Corresponding Secretary, Fred Markoe; Recording Secretary, E. H. Naylor; Treasurer, Wm. J. Gifford; Senior M. M., W. J. Courtney; Junior M. M., Wm. Topley; Sentinel, Walter Long; Chaplain, Chas. C. Cook.

Wednesday afternoon there was a pleasant trolley ride in special cars to Sommers Point, where the delegates were treated to a clam bake, at the conclusion of which the return trip of nine miles was made in record time. The delegates were unanimous in declaring Atlantic City the best place on the map at which to hold a convention, and all gave three cheers for the Committee of Atlantic City Engineers, who had

made their stay so pleasant. The members of this very efficient Committee were W. S. Price, R. S. Peterson, John A. Beste, A. M. Plummer and A. H. Francks.

The American Exhibitors' Association.

The American Exhibitors' Association, which was organized at Milwaukee a year ago, for the purpose of holding exhibits of power plant equipment in connection with the A. O. S. E. conventions did not have an exhibit at Atlantic City this year, owing to the great exhibit of the National Car Builders' and Railway Supply Men's Associations, held in Atlantic City at the same time, and to which the engineers had free access. But it is the intention to have an exhibit in connection with the 1908 convention of the order, which is to be held in Baltimore. The American Exhibitors' Association held a meeting in Atlantic City and elected the following officers: President, Wm. G. Le Compte, of Jenkins Bros.; Vice-President, C. A. Hopper, of the Keystone Lubricating Co.; Secretary, John Armour, of the Hill Publishing Co.

THE CAR BUILDERS' CONVENTION.

A pleasant feature in connection with the Engineers' Convention was the fact that its business sessions were held in one of the assembly rooms over the steel pier at the same time as the big joint conventions of the National Car Builders Association and National Railway Supply Men, who filled the great pier from end to end, with eleven hundred exhibits of railway equipment, special tools, machinery and supplies, much of which was of direct interest to stationary engineers.

The following is brief mention of a few of the exhibits of manufacturers, who are well known to the stationary power plant trade:

Philip S. Justice & Co., Philadelphia, hydraulic jacks, which are lowered by thumb screw, an exclusive feature. Represented by Mr. Mitchell and Mr. O. L. Wright.

Franklin Mfg. Co., Franklin Pa., Asbestos Century Shingles and Pipe Coverings. Their shingles and corrugated sheathing of the same material get their name from the belief that they will last a century. Represented by R. J. Evans, Wallace Johnson, G. S. Stewart, Mr. Alfred and Mr. Walsh.

Garlock Packing Co., of Palmyra, N. J., fibrous and metallic packings for steam water ammonia and every kind of service. They were represented by L. E. Adams, W. R. Haggart, F. H. Ebert, Geo. L. McCabe, D. J. Murray, Chas. Barnes, E. H. Morrison, E. C. Adams, David Newhall, B. J. Miller, Wm. Taylor, L. E. Goggin, Chas. Hadcock, Geo. Wismer, F. S. Buckley, and some others.

Keystone Lubricating Co., Philadelphia, showed a miniature engine belted to a pulley driving a line of shafting and a motor all equipped with miniature cups and lubricated with Keystone Grease; also a small pillar block or wall bracket lubricated with Keystone by the use of funnel cups, held in place with their new wood bushing. They were represented by A. C. Buzby, H. A. Buzby, Warren Buzby and C. A. Hopper.

Walson, Stillman Co., New York, Hydraulic Jacks and Machinery. Geo. L. Gillon and Edward A. Johnson.

John R. Livezey, Philadelphia, showed a handsome exhibit of pipe coverings and insulating materials, including nonpareil cork moulded coverings, sheet cork for cold storage insulation, cork boards and cork flooring, which latter is noiseless and very durable. Also a line of Norristown asbestos and magnesia coverings, wool felt and asbestos air cell. An interesting feature of this exhibit was two excellent charts, showing the exact method of insulating a cold storage plant and a brewery. H. L. Souders, C. P. Williams and Mr. Livezey.

Western Tube Co., Kewanee, Ill., showed a large exhibit of Kewanee Union's high duty metal valves and cocks, malleable cast iron and brass fittings, also iron body valves. N. J. Higginbotham.

H. B. Underwood & Co., engine repair specialists, Philadelphia, exhibited a portable boring bar for locomotive work. This is believed to be the only successful machine ever made for that purpose; also their two cylinder air or steam motor for driving a portable valve seat rotary planer, and others of their well-known emergency repair tools, cylinder rings and metallic piston packings. A. D. Pedrick and Chas. O. Ralph.

Holmes Metallic Packing Co., Wilkes-Barre, Pa., showed the largest and smallest metalic packings ever exhibited, ranging from 13½ down to ⅛ inch. They aslo showed one of their automobile packings. Mr. Geo. Rollins, Fred G. Rollins and F. E. Emery.

Dearborn Drug & Chemical Works were represented by Mr. Robert F. Carr, Geo. Carr, G. F. Duemler, H. G. McConnaughy and D. E. Cain.

Electric Storage Battery Co., of Philadelphia, showed a large exhibit of storage batteries and chloride accumulators. W. F. Bauer and H. E. Hunt.

Philip Carey Mfg. Co., Lockland, Ohio, pipe coverings and insulating materials, chief among which was their famous 85 per cent. magnesia. S. J. Bowling, W. H. Scobie, N. R. Kenny.

Paul Dickinson, Chicago. The universal cast iron ventilator, which is claimed to be indestructable, weather proof and adjustable to any pitch of roof. A. J. Filkins and J. A. Meaden.

Chicago Pneumatic Tool Co. had a large exhibit of riveters, grinders, drills, hammers and hoists, which were ably demonstrated by Mr. Aldcorn, Mr. Coates, Mr. Small, Mr. Smith and Mr. Severn. During the exhibition the compressor, which furnished air for the tools in this exhibit, ran out of oil. A can of No. 6 Keystone Grease was furnished and used in the cylinder, giving far better results than the oil. Keystone "No. 6" is a liquid grease and is said to be without an equal for the air cylinder of compressors, and also a great lubricant for ring oiling bearings.

Bowser oil cabinets and self-measuring oil tanks made one of the most attractive exhibits of the entire show and attracted many engineers. The demonstraters were C. A. Dunkelberg, W. T. Simpson and W. A. Pitcher.

Detroit Lubricator Co., Detroit, showed a three feed sectional lubricator. Their No. 21 lubricator with a new style gauge glass and a seven-feed lubricator for superheated steam locomotives. H. J. Lord, A. B. Wetmore, John Arnold and A. D. Homard.

The Mason Regulator Co., Boston, Mass., had a nice exhibit of reducing valves, balanced valves and air pump governors, with Mr. Frank A. Morrison in charge.

American Blower Co., Detroit, fans and heaters, also a large, complete model of moist air dry kiln. C. W. Old, H. F. Old and R. B. Bedford.

H. W. Johns-Manville Co., New York, pipe coverings, packings and electric fuse devices. Represented by J. E. Meek, W. F. Taylor, J. W. Allen, C. E. Murphy, J. H. Trent, J. C. Younglove, F. M. Gilmore, E. C. Sawyer and H. O. Fittinger.

Wm. Sellers & Co., Philadelphia, Sellers' injectors, main check and stop valves and a feed water strainer, a device which is attached to the main feed line near the injector to prevent the passage of sticks, gravel and other foreign matter.

Ashton Valve Co., Boston, pressure gauges, recording gauges and pop valves. Albert C. Ashton and Frank J. Corbett.

Adam Cook's Sons, New York, makers of Albany Grease, were represented by G. E. Tanberg.

L. J. Bordo & Co., Philadelphia, blow-off valves and swing joints. L. J. Bordo, E. A. Knowlton, C. W. Allen, E. W. Hodgkins and C. R. Weaver.

By far the most artistic display at the show was that of the Nathan Mfg. Co., New York. Their booth was finished in mahogany and gold with red plush drapery and stocked with a complete line of valves, lubricators, injectors, whistles, etc.

France Packing Co., Philadelphia, showed a large line of metallic sectional ring packings, fibrous packings and sheet packs, also a large display of France automatic grease cups. They were represented by Mr. A. W. France, L. T. Safford and J. K. Rutherford.

Joseph T. Ryerson & Son, Chicago, Continental boilers, a new tube cleaning device and a portable automatic key seating machine. Edw. T. Hindel, G. H. Pearsall and H. A. Gray.

Jenkins Bros., New York, showed a complete line of Jenkins valves, including their new high pressure gate and globe valves, some sample rolls of "96" packing, and the following samples of their good-looking ing bunch of salesmen, Chas. W. Martin, Jr., H. G. Logan, W. G. Le Compte, Joseph Williams, H. D. Gordon, J. C. McHugh, A. C. Langston, H. P. Lescher and Samuel Laird.

Homestead Valve Mfg. Co., Pittsburg, Pa., blow-off valves. Three and four-way valves and straightway high pressure valves, both in the screwed and angle pattern. They were represented by Mr. O. L. Rhodes and Mr. Schuchman.

Carborundum Co., Niagara Falls. Carborundum crystals, carborundum paper and corborundum cloth, also a new shop blue-print system for grinding wheels to insure accuracy. Their representatives were Ed. J. Ames, R. B. Fuller, Chas. Nicholson, W. W. Sanderson, C. C. Schumaker and C. O. Taylor.

American Steam Gauge & Valve Mfg. Co., of Boston, occupied one of the special side extension booths handsomely decorated and furnished with a number of upholstered easy chairs for the convenience of visitors. Their display included American Thompson Improved Indicators, American Dead-weight Gauge Tester, American Pop Safety Valves and American Combined Pressure and Recording Gauges. They were represented by Mr. R. B. Phillips, Gardner Cornett, C. A. Allen and Horace Parker.

Green, Tweed & Co., New York, occupied a large space immediately in front of the stage in the main ball-room, where they had a handsome exhibit of Palmetto Packings, sample spools of which were given to engineers visiting the booth. They also gave out a neat metallic badge, bearing the name Palmetto, to which was fixed a chirping beetle, which made a highly popular souvenir. The little chirpers could be

heard every where. Their representatives were H. S. Demarest, F. E. Ransley and B. M. Bulkley.

Clement Restine Co. showed a complete line of Belmont packings, hose and mechanical rubber goods, also the Riggins blow-off valve. Norman Bruce Miller, J. E. Sulger, A. C. Ergler and Mr. Restine were their representatives.

N. B. O. packings, hose, gaskets, pump valves and other mechanical rubber goods were exhibited by the Home Rubber Co., of Trenton, N. J. The exhibit was in charge of Mr. A. R. Foley, who is well known and popular in the steam field.

A. C. Clark & Co. showed several working models of the Clark Mechanical Boiler Cleaner; all the models were of glass, easily showing the facilities with which the apparatus removes mud, sludge and other foreign matter from the boiler. J. C. Mohr and W. C. Smith were the demonstraters.

Tote, Jones & Co., Pittsburgh, Pa., showed a line of oil and gas burners for oil and gas burning furnaces, which were looked after by R. G. Kirkwood.

Schutte & Koerting Co., Philadelphia, showed the Universal Koerting Injector and a splendid line of water and steam jet apparatus, also syphons and an interesting line of special valves, in charge of S. C. Smith and J. J. Gesselman.

H. G. Hammett, Troy, N. Y., showed Trojan sectional ring metallic packing, which seemed to take well with the delegates. J. J. Leighton.

Morgan & Wright, Detroit, showed White Seal sheet packings, triangle piston packings and Marganite pump packing. They were represented by Mr. Hudson Dickerman.

Joseph Dixon Crucible Co. showed an immense paint can with a passage way through it for visitors. Inside were a collection of bent mirrors where the visitors became in-fat-uated. They also showed a line of graphite lubricants and graphite brushes. C. H. Potts, L. H. Snyder, John J. Tucker, W. A. Houston, A. C. Bowles, R. A. Browne and H. Neally were their representatives.

American Water Softener Co., Philadelphia, gave interesting demonstrations with a complete model of their water softener apparatus which attracted a large number of delegates and resulted in some good contracts, the two largest being for installations of 30,000 gallons capacity. There were represented by W. H. P. Fisher, A. C. Tomlinson, A. C. Emlen and A. S. Garrett.

Watson & McDaniel, Philadelphia, showed the new McDaniel Steam Trap and Watson's Pump Regulator, in charge of Mr. Jas. Watson, Jr., and Fred L. Jahn.

Michigan Lubricator Co., Detroit, showed a large line of lubricators and a new automatic drain stem which prevents loss of oil in draining and refilling lubricators.

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., showed the Jackson Belt Lacing Machine, which laces any kind of belt almost as quick as a cat can wink her eye, and does it better than by hand. Mr. William Carlisle Johnson showed it.

Geo. W. Lord Co., Philadelphia, had a fine exhibit of Lord's Water Purifying Chemicals, which was looked after by their popular representatives, Captain J. E. Doughty, Col. Nat. P. Lane, Mr. J. H. Blanchard and Mr. V. O. Lawrence.

Cancos Mfg. Co., Philadelphia, makers of Black Squadron Packing, were represented by S. M. Best and Mr. Costello.

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Thirtieth Convention of the National Electric Light Association.

The thirtieth convention of the National Electric Light Association, which took place in Washington, D. C., on June 3-8, was the most sucessful ever held in the history of the organization. Beginning on Tuesday morning, June 4, when the convention was formally opened by President Arthur Williams, and continuing until Friday evening, June 7, the convention was one continuous round of educational and entertainment activity. The number of papers read on the various phases of the electric lighting industry was exceedingly large, and their scope indicated the many-sided aspects which the production, distribution and selling of electricity has taken on. Probably no one body in this country has done more to unify and investigate the best practice of the lighting art, and this year's meeting was of very great importance, owing to the confusion field.

The growth of the electric lighting industry during the past thirteen years was brought out by President Williams in his opening address, in which he said that while there were 2,300 central stations in the United States in 1894, there were about 5,000 central stations in this country at the present time, representing an investment of $850,000,000 and a yearly revenue of $170,000,000. During that time, however, the problems which the association has had to meet have gradually changed from technical and mechanical matters to those of a more commercial nature.

As a result of the increased membership of the association, which now includes about 1,300 members, there were in attendance about 1,500 members and guests when the convention was in full swing. The convention headquarters was at the Williard Hotel, on the tenth floor of which the exhibition of electrical appliances and the educational meetings were held.

After the formal opening on Tuesday morning, at which General George H. Harris, vice-president of the Washington Railway and Electric Company, and Hon. H. B. F. Macfarland, president of the Board of Commissioners, welcomed the visiting members, the various papers were then taken up. The first and largest paper of the meeting was the report of the Committee on Progress, prepared by T. C. Martin, who outlined in the broadest possible manner the various changes and improvements that have taken place during the past year. Then followed papers on Accidents, Power-Factor Correction of Synchronous Motors, the Question Box, Insurance, and Fire Hazard of Electricity. The Tuesday evening session was taken up with a discussion of the Uniform System of Accounting, Differential Rates and Lightning Protective Apparatus. Wednesday morning papers included the Metallic Oxide Arc Lamp, Indefinite Candle Powers in Municipal Contracts, Efficiency of Various Methods of Illumination, and Street Lighting Specifications. Wednesday evening, paper on Frequencies of Flicker at Which Variations in Illumination Vanish, by Dr. A. E. Kennelly, and Application of Gas Power to Central Station Work, by J. R. Bibbins, preceded a very able paper on Lightning and Lightning Protection, by Dr. C. P. Steinmetz. Thursday's sessions were very full ones, the principal papers being Recent Turbine Developments, Balancers versus Three-Wire Dynamos, Producer Gas Engines for Central Station Work, the Future of the Gas Engine; the other papers, as well as those on Friday, being devoted chiefly to the "Business Getting" of electric companies.

Sandwiched between all these numerous business meetings there was an excellent round of pleasure provided, in which all the members and guests took an active interest. Monday evening the exhibition was formally opened, followed by a reception and dancing. Tuesday afternoon a special reception was held at the White House by President Roosevelt, who shook each person's hand attending. Wednesday afternoon there was an exhibition cavalry and field drill at Fort Meyer, and in the evening a brilliant dance was given in the ballroom. Thursday afternoon was spent in a ride down the Potomac River to Washington's home at Mt. Vernon, a very enjoyable luncheon being served on the boat. To supplement these pleasures, there were plenty of automobile rides for the ladies and visits to power houses for the men.

The exhibition was held in the large ballroom of the Williard Hotel, on the tenth floor. All the booths were uniform in style and decoration, as they were painted in white, with gold decoration, it gave the whole exhibtion a very refined appearance. The majority of the exhibits were devoted to incandescent and arc lamps, electrical instruments and electric wiring appliances, no attempt being made by any exhibitor to

show any operating machinery. The companies handling the larger machinery showed protographs of their various products.

The most interesting exhibit was that of the National Electric Lamp Association, as it was equipped with all the various types of high-efficiency lamps sold by members of the National Association. The tungsten street series lamps of 40 candle power, 5½ ampere type, operating nine in series on a 110-volt circuit, was the most interesting and newest feature. Tantalum lamps and metallized filament lamps shared with the tungsten lamps in adding brilliancy to the exhibit. Among the electrical companies represented were the Westinghouse, General Electric, National Carbon Company, Standard Underground Cable Company, Excello Arc Lamp Company, Crouse-Hinds Company, Crocker-Wheeler Company, Keystone Electrical Instrument Company, Jandus Electric Company, Novelty Incandescent Lamp Company, Wagner Electric Manufacturing Company, Western Electric Company, Fibre Conduit Company, Simplex Electric Heating Company, Philadelphia Electrical and Manufacturing Company, American Instrument Company, Fort Wayne Electric Works, Western Electric Company, Pittsburg Transformer Company, New York Beck Lamp Company, Standard Vitrified Conduit Company. Among the companies showing mechanical devices and supplies for the power plant were the Oil Waste and Saving Machine Company, who had on exhibition an oil and waste-saving machine for extracting grease, and a turbine centrifugal oil filter; the Dearborn Drug and Chemical Company, Ridgway Dynamo and Engine Company, and Electric Storage Battery Company.

The success of the convention was due to the untiring efforts of its officers and committees, especially W. C. L. Eglin, who, as secretary and treasurer, had an enormous number of details to look after. At the close of the convention the following named officers were elected for the ensuing year: President, Dudley Farrand, Newark, N. J.; first vice-president, Alex. Dow, Detroit, Mich.; second vice-president, W. C. L. Eglin, Philadelphia; secretary, W. W. Freeman, Brooklyn, N. Y. Executive Committee: George H. Harries, Washington; A. J. DeCamp, Philadelphia; Samuel Scovil, Cleveland.

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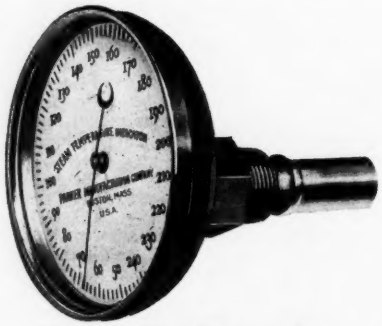
The Standard Dial Thermometers.

It is very important, especially in connection with steam boilers, feed water heaters, condensers, cooling towers, etc., to know the temperatures of the water or steam under the different conditions, as these temperatures are often an indication of the proper working of the plant. Many times, however, these temperatures are not obtainable, owing to broken thermometers, which are generally found in that condition when most required. To replace the mercury thermometer, which is not an engine room instrument, dial thermometers for all purposes are being used. The particular advantages of the dial thermometers besides those mentioned above are their accuracy after long continued use and the legibility of their dial. They can be easily read in the darkest places.

A dial thermometer, which is used for steam temperature service, is shown in the accompanying illustration. The dial is made of white enamel burnt on copper, so that it will not corrode. The case is made solid, with the nut cast on the case, and should it become damaged from any cause, it can be easily repaired. They are said to be very accurate after long continued use, and are in use by the United States Government.

The Parker Manufacturing Company, 8 Clifton Street, Boston, Mass., are the manufacturers of these dial thermometers, as well as other special instruments and appliances for the engine room.

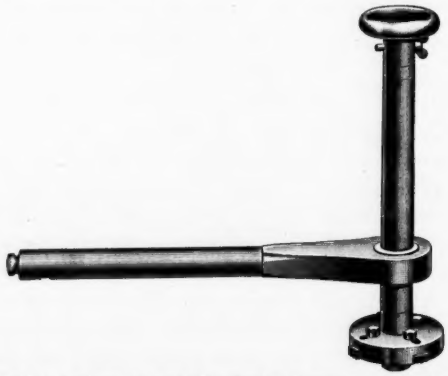


Standard Dial Thermometer

The Hall & Cullen Adjustable Valve Reseating Machine.

The Hall and Cullen adjustable valve reseating machine, shown in the accompanying illustration, is designed for the purpose of reseating pump valves. It is simple in construction and is made of tool steel for cutting brass seats. It is applied to the valve seat without removing the pump from the foundation or disconnecting any connection except the valve cover, which allows the tool to be placed in position. It is said that the eight valve seats on a duplex pump can be reseated in less than two hours.

The machine is equipped with two cutter heads, the small head being made with three sizes of sectional cutters, from 2½ up to 3½ inches diameter, the large head having two sizes of sectional cutters, cutting from 3⅞ to 5 inches and 5 up to 7 inches diameter. To set the cutters, two are left close to the stud to face the centre, the other two being set out to the size desired to cut. The studs are made in three sizes, from ½ up to ¾ inch. They are made with a thread and shoulder to allow various ends to be screwed on it.

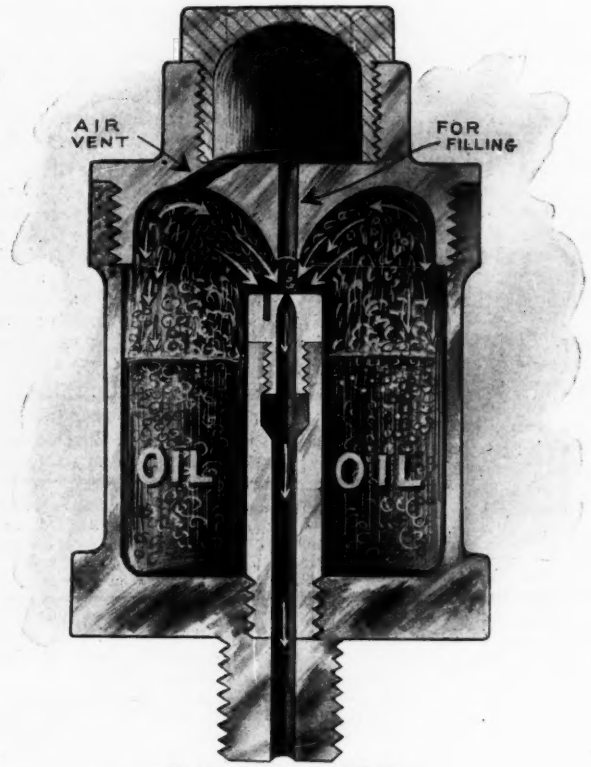


Hall & Cullen Adjustable Valve Reseating Machine

By reseating the pump valves two or three a year, the pump is kept in good condition, thus saving pump troubles that arise from bad seats and short water in boilers. For further information address Hall & Cullen, 1321 N. Francisco Avenue, Chicago, Ill.

The Bangs Automatic Oil Cup.

The accompanying illustration represents a section of the Bangs Automatic Oil Cup, which shows the principle of the cup and the effect of reciprocal motion on oil and feed arrangement. The features of the cup are its positive feed arrangement, the certainty of its not being stopped up by sediment and its oil economy. It has been used for a number of years on stationary engines in power plants, on auxiliary apparatus, on ocean vessels and on locomotives.



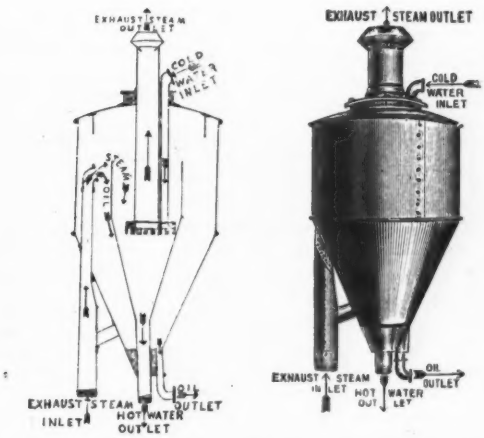
Bangs Automatic Oil Cup

The cup shown is designed specially for use on eccentrics, crossheads, crankpins or any reciprocal bearings, and can be placed in any position. The oil is thrown to the top of the cup by the reciprocal motion and is directed downwards to the feed-hole by the radial curve guides. A small amount of oil is distributed each stroke and the more speed the more oil is fed. Its positive feed is due to the parabola shape of the feed duct, which gives a smaller opening at the top than any other part of the duct so that the smallest particle of sediment once started will pass on through. The opening cannot be clogged up, as the action of the oil in the duct or the action of the oil over the feed-hole will remove it. When the engine stops, the flow of oil stops. It is filled by removing the plug in the cover, or should it be desirable to fill the cup without stopping the engine, the cup is supplied with a spring cap. Four sizes of feed accompany each cup, any of which can be used to suit a given condition.

Various modifications of this cup are made to suit stationary bearings, loose pulleys, piston rods and valve stems, etc., in which the supply of oil is also regulated by the speed of the rubbing surfaces. The material out of which the cups are made is either aluminium, brass or iron, as desired. The Automatic Oil Cup Co., of 180 Huron Street, Milwaukee, Wis., are manufacturers.

The Dillon Exhaust Steam Condenser, Water Heater, Purifier and Oil Extractor.

An exhaust steam condenser which possesses a number of interesting and valuable features is shown in the accompanying illustration. Besides performing the usual functions of an exhaust head, this device extracts the oil from the steam, purifies and heats the water for the boiler feed or other purposes, condenses the exhaust steam and removes the back pressure from the engine.



The Dillon Exhaust Steam Condenser, Water Heater, Purifier and Oil Extractor

Its method of operation is as follows: The exhaust steam from the engine is led into the side of the exhaust head, where it meets with a circular baffle plate. Any oil or moisture in the steam is separated, and passes to the bottom of the device and out of the oil outlet. The steam then passes around the baffle plate and meets the cold water, which is led into the condenser at the top and comes out through a brass spray ring in the centre of the steam space. The result is that the steam is condensed, thus removing any back pressure on the engine and at the same time it acts as a feed-water heater for heating the supply of water to the boiler. Any remaining steam or air is allowed to escape through a liberal opening at the top.

The condenser can be placed anywhere above the engine, either inside the building or outside on the roof. If placed inside, the exhaust outlet pipe is extended to the open air. They can also be made self-regulating by a float valve that regulates the inflow of cold water. The float is placed in the hot-water tank and the supply to the condenser is regulated by the amount of hot water required. The condensers will heat from 5,000 to 50,000 gallons of water per day of ten hours to a temperature of 180 to 200 degrees, if used for heating the feed-water alone, and when used for heating large quantities of water, as in laundries, the average temperature of the water will be about 125 degrees.

Mason & Ross, 117 Yerkes Street, Northville, Mich., are the manufacturers from whom further information pertaining to the use of these condensers in any particular plant can be obtained.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

An interesting thing about the Mansfield ball-bearing grate is that, although it is a shaking grate, it can be placed under any boiler as quickly as common bars and without the use of bolts or screws. A booklet describing these grates in detail has been issued by Wm. E. Rider & Co., Mansfield, Mass.

Engineers having trouble with belts that run out in the weather or in damp places may learn some things that will help them from the catalogue of the Main Belting Co., 1225 Carpenter Street, Philadelphia.

The year book of the American Society of Refrigerating Engineers for 1907, which has just been issued, gives the constitution and by-laws of the society, together with the names of its officers and members. A copy of this book will be mailed to any reader of THE PRACTICAL ENGINEER upon request. Address, W. H. Ross, Secretary, 258 Broadway, New York.

During the past month Henry C. Tulley received a large number of orders for Tulley's Handbook on Engineering, among which was an order from D. Van Nostrand & Co., for 25 copies; one order from the G. W. Lord Co., for 25 copies; one from Technical Supply Co., of Scranton, for 25 copies; E. V. Smith, Moose Jaw, Canada, 12 copies; J. L. Artman, Sheboygan, Wis., 5 copies, and scores of orders for single copies.

A. D. Granger & Co. have moved to the new West Street Building, at the corner of Cedar and West Streets, New York.

Mr. John T. Lindstrom, of Allentown, Pa., maker of the Lindstrom Steam Trap, writes us that orders for his traps have been pouring in so fast that he contemplates the building of a new and much larger plant. His engine repair department has also ben taxed to its full capacity.

The Holmes Metallic Packing Co., of Wilkes-Barre, Pa., have sent us a schedule showing the results obtained from the use of Holmes' packing on a Philadelphia & Reading Railroad locomotive. The left piston and right valve stem being packed with Holmes and the opposite rod and stem with another make of metallic packing. The card shows that after 16 months the locomotive having covered approximately 75,000 miles under 205 pounds steam pressure. The Holmes packing, rod and stem were in good condition, while 41 sets of the other packing had been worn out.

A circular, printed on a sheet of cork no thicker than a page of THE PRACTICAL ENGINEER, has been received from John R. Livezey, 1936 Sansom Street, Philadelphia. Mr. Livezey is the pipe covering man and expert on the insulation of cold storage and refrigeration plants.

The Norbert-Wolff Company, 472 Greenwich Street, New York City, are receiving a great many inquiries regarding their special offer in connection with the Wolff Belt Dressing. Orders have been received the past month in excess of any previous month in the history of the company, many of them from the largest concerns in the country, who figure closely as to economies in operating and maintainance expense. A list of some of the prominent users as well as testimonials and details of their liberal offer giving privilege of testing the dressing, will be sent upon request.

Jas. Bonar & Co., 716 Frick Building, Pittsburgh, Pa., have issued a new circular, calling special attention to their open type of feed water heater, explaining the system of spraying devices and pans, which gives an even distribution and a very high temperature of feed water. It also explains the system of purification. If you are contemplating the purchase of a new heater, send for a copy.

The Ohio Injector Company, Wadsworth, Ohio, has its large 72 page catalogue for 1907 ready for distribution. This handsome edition illustrates and describes their complete line of high grade injectors, ejectors, lubricators, steam specialties, oiling devices, etc., for all classes of service and will be mailed free to any engineer interested in devices of this class. Don't put it off, but write at once before the edition is exhausted.

The Sarco Fuel Saving & Engineering Co., 92 West Street, New York, have issued a large, new circular of special interest to every user of a Roney Stoker. Engineers having Roney Stokers in their plants should write for a copy.

The Dillon Exhaust Steam Condenser, Water Heater, Purifier and Oil Extractor represents a new combination of well-known principles, the value of which will be appreciated by every engineer. A short description of it appears on another page of this issue, and a more complete description will be found in a new catalog, issued by Mason & Ross, Northville, Mich. This device is worth looking into. It is proving to be a money saver.

The Cherry Chemical Co., manufacturers of the Red Seal Boiler Compound, 10 N. 19th Street, Philadelphia, Pa., tell us that they sold more boiler compound during the month of May than they have sold in any one month in fourteen years. This indicates that Red Seal is meeting with success far beyond the expectations of the manufacturers. Mr. Oliver Braden, the manager of this company, wishes to thank the many friends who have stood by him for so many years. Engineers who are not well supplied with mechanical books would do well to write to this company, as they have a proposition to make which we feel confident will meet with the approval of the steam users. In addition to that, they will mail to you one of their rulers.

The D. T. Williams Valve Company, of Cincinnati, have opened an eastern branch office in charge of Charles K. Thomas, Eastern Sales Agent, at 26 Cortlandt Street, New York City.

The large new catalog which has been announced by the Burt Mfg. Co., 204 Main Street, Akron, Ohio, for several months past, is now out and ready for distribution. Those who have not yet written for a copy should do so at once, for it's a beauty.

The Sargent Steam Meter Co., of Chicago, have moved to 1005 Plymouth Building.

Frank B. Gilbreth, of New York, has a contract calling for the erection of a modern factory at a cost of $300,000 for the Heywood Bros. and Wakefield Co., at Gardner, Mass. The contract, which is on the cost-plus-a-fixed-sum basis, calls for a main building 75 x 425 feet, and an office building 60 x 60 feet, both of structural steel. Each will be four story and basement. The architects and engineers are Lee and Hewitt, 1123 Broadway, New York.

The Liberty Manufacturing Company, 6409 Susquehanna Street, Pittsburg, Pa., have just issued Bulletin No. 18, describing their Liberty Heavy Duty Turbine Cleaner, which is of all steel construction and of unlimited power and capacity. It will remove scale of any thickness quickly and cheapy. It requires but one man to operate and is guaranteed not to injure the tubes.

100 Letter Heads, 100 Envelopes, and 100 Business Cards and Case, $1.50 postpaid Samples 2c. R. ELLIOT, Box 1376, St. Louis

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address FRANCE PACKING Co., Tacony, Phila., Pa.

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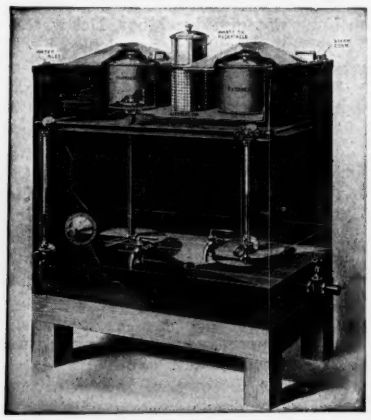
Where Shall We Send Your Copy?

What Do You Say To Cutting Oil Bills In Half?



That is precisely what you can do with a "Unit" Oil Filter. It saves from 50 to 90 per cent of your "drip" oil — renders it fit for repeated use, by making it absolutely clean and free from all sediment. The "Unit" has a capacity of from 200 to 250 gallons every twenty-four hours— **one works just as profitably as a number.**

The Cross Oil Filter Multiplies Profits

through enabling you to use lubricating oil over and over again It saves fifty toseventy-five per cent of the oil used, by removing the dirt and grit. Requires little or no attention after starting—

no expense beyond the trifling cost for waste. Ask about it.

The Burt Manufacturing Company, Largest Manufacturers of Oil Filters in the World
204 MAIN ST., AKRON, O, U. S. A.

ALSO SUPPLIED BY ENGINE BUILDERS, DEALERS AND POWER CONTRACTORS

We are in receipt of Bulletin No. 25, from the Liberty Manufacturing Company, 6409 Susquehanna Street, Pittsburg, Pa., describing the pneumatic tube cleaner, an appliance which they claim has extreme power and is most effective in heavy scale, as its name indicates. It is operated by air pressure and is for use where the water supply is limited.

At a special meeting of the directors of the Joseph Dixon Crucible Company, held May 31, to take action on the death of Vice-President and Treasurer John A. Walker, Geo. T. Smith was elected Vice-President, Geo. E. Long, Treasurer, and Harry Dailey was elected Director and Secretary.

The Stephenson Manufacturing Co., of Albany, N. Y., who are the original and only makers of Stephenson Bar Belt Dressing, advise us that unscrupulous parties are making a bold attempt to steal their business, having gone so far as to closely copy the Stephenson stick and wrapper, and even claiming that the imitation which they offer at a tempting price is the original article. Stephenson Bar Belt Dressing has been extensively advertised and bears an excellent reputation, every stick bears their registered trade mark on the wrapper—the man with the cog-wheel face. Those who believe in fair methods should insist upon having the genuine Stephenson.

The subject of lubrication is as old as the hills, and yet it is still an open question as to whether oil or grease is the better lubricant. In many instances it depends entirely upon the character of the work that is being done as to which is best—for instance, on cylinder lubrication, there never has ben a grease invented that would work as well as oil, while for cold plungers of pumps, elevators, etc., there is no oil that equals a good grease. Indeed, grease is now largely used on almost every kind of machinery with perfect satisfaction, especially in textile mills, where there is danger of the product being injured by drips from the hanger boxes. Keystone Grease is quaranteed by the manufacturers not to drip; it is also guaranteed by the manufacturers to be 100 per cent. pure—there is no foreign ingredients used to give it "body." The process used in its manufacture renders this unnecessary, and enables the manufacturers to guarantee that one pound of Keystone Grease will lubricate better and last longer than three to four pounds of any other grease, or four to six gallons of the best lubricating oil. See their ad. this month—they are sending free a large can of Keystone Grease, a brass grease cup and an engineer's cap, to any engineer sending his name. Write for them.

The Sight Feed Oil Pump Co., of Milwaukee, announces that Mr. W. E. Richardson will take active charge of the company's affairs about July 1st. Mr. Richardson, who is president of the company and inventor of the well-known Richardson Oil Pumps, was for sixteen years in the employ of the Allis-Chalmers Co., and for the past two years has been with the Westinghouse Machine Co., of Pittsburg, as General Superintendent of Erection. The Oil Pump Company's good fortune will be of interest to a wide circle of his friends in engineering and power plant fields, whose good wishes follow him in this new activity.

"Test the Friction Load" is the title of a new leaflet just issued by the Keystone Lubricating Co., in which they suggest a method of testing the friction load. Then they go on to tell what Keystone Grease will do. They guarantee that Keystone Grease will relieve the engine of 33 1/3 per cent. of its present friction load. Send for a copy.

"The Direct Separator Company, of Syracuse, N. Y., have recently arranged with Edward P. Brock & Co., 104 High Street, Boston, Mass., for the sale of their steam and oil separators and exhaust heads in the New England States. The Company are very busy, and are at present increasing their shop."

White Star Continuous Oiling Systems, which mechanically keep engine bearings supplied with a steady stream of pure lubricating oil, have recently been installed by the Pittsburgh Gauge & Suppy Co., Pittsburgh, Pa., in the power plants of the following concerns:

Windsor, Essex & L. S. Rapid Ry. Co., Kingsville, Ont.
Buick Motor Co., Flint, Mich.
Warwick Mills, Centerville, R. I.
Fitchburg Yarn Co., Fitchburg, Mass.
Kaufmann Bros., Cincinnati, Ohio.
Washington Electric L. & P. Co., Washington, Pa.
Federal Furnace Co., Chicago, Ill.
American Wood Working Machine Co., Rochester, N. Y.
Utica Knitting Co., Utica, N. Y.
Harrisburg Lt., Ht. & Power Co., Harrisburg, Pa.
Baldwin Locomotive Works, Philadelphia, Pa.
Ames Iron Works, Philadelphia, Pa.
R. A. Long Building, Kansas City, Mo.
Reo Motor Car Co., Lansing, Mich.

A very desirable catalog describing the White Star Systems in detail will be mailed to any one interested in the subject.

The McDaniel Suction Tee is a fitting that is said to make all bad jobs of steam heating work well. It prevents one steam connection from backing up on another and prevents noise. It is made by Watson & McDaniel, 147 N. Seventh Street, Philadelphia.

The American Combined Pressure and Recording Gauge is an interesting and decidedly valuable instrument in any steam plant; indeed, there are few things about a power plant that are of more importance in the matter of promoting vigilance and economy. A circular describing the instrument in detail and showing both sectional and exterior views of it will be mailed to any reader by the American Steam Gauge & Valve Mfg. Co., Boston, Mass. Ask for circular 23-P.

"Efficient Bearings" is the title of a well illustrated catalogue, issued by the Franklin Filter Co., 308 N. Commercial Street, St. Louis, Mo., in which the construction and operation of the Franklin Oil Filter is described. One of the particular features of this filter is the jacket which gives the oil an even temperature, thus allowing it to distribute evenly, so that it can positively liberate the impurities. The Franklin oiling system, the Franklin sight feeders and other specialties are also described in this catalogue.

The Stillman-Carmichael Co., 19 Pearl Street, Boston, Mass., are issuing a new circular which describes the twelve recent improvements which have been made on the Stillman-Carmichael Improved Automatic Damper Regulator, together with its method of operation. Directions for installing the regulator are also embodied in the circular.

The Kelley Forced Draft System, by means of which cheaper grades of fuel can be burnt, is an arrangement which remedies many of the draft troubles found around power plants. Consisting, as it does, of a simple nozzle surrounded by a casing, it gives a simple automatic natural draft of any desired strength. Chas. T. Luce Co., 160 Congress Street, Boston, Mass., are the manufacturers, who will be glad to hear of any smoke or draft troubles and they will send an expert to examine them if requested.

The Copes Pump Governor controls the speed of the pump with which it is connected by means of hydraulic pressure on one end of the piston. No diaphrams or springs are used in its construction and it is applicable to to boiler feed pumps, elevator pressure tank pumps and fire pumps. It has been approved by the Board of Supervising Inspectors United States Steamboat Inspection Service for use on steam vessels. A catalog of this interesting device will be sent to any engineer by the American Boiler Economy Co., Mutual Life Building, Philadelphia, Pa.

The Southern Pacific Company have recently awarded to The George E. Dow Pumping Engine Company, of San Francisco, contract for installing 285 miles of pipe line for pumping oil through the San Joaquin Valley to the sea.

This line will have twenty-four power stations, in each of which will be installed three Edge Moor Water Tube Boilers of 250 Horse Power each, manufactured by the Edge Moor Iron Company, of Edge Moor, Delaware.

These boilers will be erected by The Tracy Engineering Company, of California, who are the Pacific agents of the Edge Moor Iron Company.

The Vanda Company, 96 Spring Street, New York, has doubled the capacity of its factory of late, and is now ready to enter the field of piston and valve rod packing. This article is constructed on different lines from any piston packing now on the market, and the strongest claims are made for it as a self-lubricator.

The pronounced satisfaction given to consumers during the last two years since this company is in the market, is a broad guarantee that their piston packing will also meet with much favor. The Vanda Company is the pioneer of the new sheet composition packing introduced in this market during the last two years.

In order to meet the increasing demand for this packing, and to have as many distributing depots as possible throughout the country, an arrangement has lately been consummated between the Vanda Company and the H. W. Johns-Manville Company, by which the latter concern will act as co-distributors for all articles manufactured by the Vanda Company. Catalogs describing the Vanda products will be mailed if requested.